BELL TELEPHONE QUARTERLY

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APRIL, 1930

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AMERICAN TELEPHONE & TELEGRAPH CO.
NEW YORK

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A Medium of Suggestion and a Record of Progress

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Better Speech

ONE of the most discussed subjects of the present day is our spoken language. The exciting cause of this interest is without question the universality of radio entertainment and the rapid adoption by American theaters of talking motion-pictures.

When radio was new, there was not at once the marked attitude of discrimination that exists to-day in the qualities of speech as reproduced by the loud speaker. Public attention was, at first, naturally centered on the novelty of broadcasting, and then on the unusual and varied features that were offered in broadcast programs. There was wonder and appreciation as radio stations and their advertisers sent out on many wave lengths the art of singers and orchestras, the thrill of sports contests, the inspiration of church services, the excitement of a Lindbergh homecoming, the solemnity of a President's inaugural.

When sound pictures arrived, however, they met a public that had had its sense of speech values stimulated and educated by almost continuous radio entertainment, and this entertainment had been free. The price of an admission ticket to a theater offering talking motion pictures included the right to criticize. And there was an almost immediate public verdict regarding the speech that was to be synchronized with action on the screen. This speech had to be acceptable, and almost overnight famous screen actors found themselves facing the necessity of improving their enunciation and pronunciation, of studying tone production, of learning to talk before an electrical mechanism that reproduced without extenuation every speech defect.

If America was, in a measure, speech conscious at the advent of the sound pictures, it is now emphatically more so. With

more than 600 licensed broadcasting stations, a radio set for every seven families, and sound pictures affording entertainment for millions weekly, the technique of speaking, as revealed by radio announcer, political orator, occasional speaker, or screen actor, is open to an analysis that is severely critical. Listeners in millions of homes, schoolrooms, and theaters, with daily opportunity for contrasting methods as well as messages, are constantly changing their standards. Speakers have become aware that the human voice is on trial everywhere.

Speech itself has thus been advertised in an inescapable way by its newer transmission agencies, and a tremendous impetus has been given to the activities that are promoting better speech. The last convention of the National Association of Teachers of Speech gave much of its time to discussion of the new conditions, hailing such events as the annual award by the American Academy of Arts and Sciences of a medal for the radio announcer using the best diction. A profusion of newspaper and magazine articles reflects, as well as stimulates, the growing realization in all sections of the country of the importance of speech, of the commercial as well as cultural value of better speech.

To the telephone companies comprising the Bell System the speech habits of telephone users have always been a matter of specialized interest. The reason for this is the fundamental one that better speech means better telephone service. A familiar expression of this interest is the educational effort that calls attention to the value of distinct enunciation and explains how telephone facilities can best be used.

From the standpoint of the number of words which the telephone user should be able to enunciate properly in order to carry on effective conversation, the task is not a large one. Recent investigations of the words used in telephone conversations show that in 500 conversations in which about 80,000 words were noted, only 2,200, or less than 3 percent, were different words. Fifty words account for 60 percent of the total

words in these conversations and 700 words account for 95 percent. Proper pronunciation, therefore, of relatively few words would go a long way towards improving the effectiveness of our speech.

It is from the standpoint of the user that telephone service is improved by better speech, and this standpoint is the one by which the telephone companies must and do measure the success of their efforts. This is because of the unique and important characteristic that differentiates telephone service from other public services, namely, that it is a personal service, placing at an individual's request a private communication channel for exclusive use between distances that may be a few feet or thousands of miles apart.

To the individual the value of this service is to a considerable extent measured by the degree of satisfaction with which he can use the facilities placed at his disposal,—by the ease with which he can understand and be understood. Anticipating his need a nationwide system is in readiness day and night, built and maintained to afford the highest practicable grade of transmission. Equipment and operating methods have been brought to such a point of efficiency that the average time for completing a long distance connection has in the last five years been reduced from 7.5 minutes to 2.4 minutes, and this despite the tremendous increase in the use of the long distance service as a business tool. Such operating features of course are in themselves contributions to the satisfaction of the user, but they are most satisfactory and beneficial when the speech transmitted is clear and intelligible as well as courteous. The important thing to note in this connection is that the telephone facilities themselves are constantly being improved so as to transmit speech more clearly and more faithfully.

Efforts to achieve this are directed at several different points in the telephone plant. Transmitters and receivers undergo continuous investigation and improvement. New types of equipment for repeater stations, through which long distance

circuits pass, are constantly being sought and better forms of apparatus are being produced. The ultimate objective of such effort to improve transmission is to reproduce, at the distant end of the telephone line, the voice of the speaker with greater fidelity. Each year new methods of operating and new developments in equipment are enabling telephone engineers to approach this objective more closely.

The conclusion of this idea is readily apparent. The more naturally the speaker's voice sounds through the distant receiver, the more discernible will be any defects that may mark his speech. The potentialities of the telephone system for service will be more fully realized, therefore, when telephone users co-operate with telephone engineers by recognizing the usefulness of careful enunciation.

The ideal of a telephone service that is good from the consumers' standpoint must naturally include a definite interest in these habits of speaking, as well as in the educational activities that have as their objective the improvement of these habits. These activities include the instruction in thousands of classrooms and lecture halls, the state and national teachers' associations, such as the National Association of Teachers of Speech and the National Council of Teachers of Speech; the publication of professional periodicals like the English Journal, the Quarterly Journal of Speech, and American Speech; the public speaking classes of the Y. M. C. A. and Y. W. C. A.; the schools of elocution and dramatic expression; the special educational efforts in behalf of those having some form of speech disorder, numbering more than one million according to government estimates. Every influence that promotes better habits of speaking must be recognnized as a co-operative agency in the improvement of telephone service.

The effort to improve telephone service is reciprocal cooperation, for better service means better speech. Telephone service as understood in the Bell System is a multitude of special activities organized and co-ordinated to the end that

"any one anywhere may talk to any one else anywhere else, quickly, clearly and at a reasonable cost." As research, development, engineering and their allied activities have made wider geographical areas accessible by telephone, the service has had a continuous influence on the speech of a constantly increasing number of telephone users.

For a quantitative analysis of this influence there are some interesting statistics. In the United States alone there are more than 20,000,000 interconnected telephones, and 9,000,000 more in Canada, Cuba, Mexico, South America, and Europe can be reached from any one of them. The rate of growth for several years has averaged 800,000 additional telephones every year. Every day in the United States the telephone wires carry more than 80,000,000 conversations. At each end of the telephone circuit over which each conversation is held some one is listening to human speech, and each of these conversations—except where the dial telephone is in use—is prefaced by a conversation with a telephone operator. Nearly 200,000,000 times a day, therefore, the vibrating diaphragm of a telephone receiver is reproducing some one's enunciation, inflection, tone, and mannerisms of speech.

The specific part of telephone service that is most often referred to as affecting our national habits of speech arises from the operation of telephone switchboards by young women whose methods of speaking have been corrected and improved during their preparatory training. Taught to speak clearly and pleasantly, their enunciation of numbers and central office names has led telephone users to habits of placing their calls in the same way and has served to emphasize the value of well-articulated speech. This is a matter of frequent comment by writers and speakers. Mr. Bernard Shaw is reported to have said recently, "People drop their vowels and syllables and everything else, and at the present time just make a noise. How on earth they make themselves understood to each other is difficult to know. It is pure laziness, but the language for-

tunately is being preserved by telephone operators and wireless announcers who have to be distinct and articulate."

Almost similar in its judgment is the remark of Dr. Frank H. Vizetelly, the editor of the New Standard Dictionary and a radio lecturer of note: "The influence of the telephone companies' system of training operators has been immeasurable, in so far as it has taught persons who use the telephone to speak carefully and enunciate clearly. There are very few of us who realize the great debt we owe to these companies for their efforts in behalf of standardized speech. To them and to the radio broadcasting companies, whose vociculturists have aided in the work, we are under an obligation that none of us can ever repay, for it is owing almost as much to their efforts as it is to the increased facilities of travel that standard English has spread."

It is always interesting to recall that the telephone itself was born in a speech laboratory. Its ancestry is the devoted interest of its inventor, Alexander Graham Bell, of his father, Alexander Melville Bell, and of his grandfather Alexander Bell, in speech and its improvement. Forty-eight books, the first published in 1845, reflect the range and thoroughness of Melville Bell's investigations. Two years after the family had removed from England to Canada, Melville Bell wrote of his son's qualifications as a teacher:

"Mr. Alexander Graham Bell having been trained for his profession from his earliest youth, and having, besides, had extensive experience,—first as my assistant, and subsequently in his own practice,—is qualified as few persons can be, for the successful treatment of cases of stammering, and other defects of speech.

"He is thoroughly acquainted with visible speech and its applications; the department of teaching the deaf to articulate having been committed from the first to his management.

"If he were not my son, I might speak more strongly, and refer to other qualifications. I content myself with testifying that he has given the most gratifying satisfaction in every engagement. I have perfect confidence in staking my professional reputation on the results of his teaching."

It was with this knowledge of speech that Bell, in 1872, opened in Boston his school of vocal physiology, as his announcement stated, "for the correction of stammering and other defects of utterance and for practical instruction in visible speech." The story of his studies, experiments and accomplishments is well known. With his long study of elementary electricity, reinforced by the special study of electricity he undertook at the urgent suggestion of Joseph Henry, in 1875, came his discovery of the principle of speech transmission by electricity, which led to the first telephone patent, in 1876, and has been developed so romantically into a national and international service of personal communication. This development has taken place in a speech laboratory, the organization of scientists called the Bell Telephone Laboratories, which conducts planned research to improve the telephone and related arts.

Naturally the telephone's scientists have included all knowledge of sound and audition in their field of investigation. With better telephone service always their objective, the ideals of better speech and better means for transmitting it are indissolubly linked. An important result is their co-operation with leaders in the movement to improve speech, and their discussion of fundamentals before professional associations and in the technical press. Nearly twenty years ago Dr. G. A. Campbell's profound basic treatise, "Telephone Intelligibility," appeared in the Philosophical Magazine. Dr. Harvey Fletcher's "Speech and Hearing" and Dr. I. B. Crandall's "Sound and Vibrating Systems" are recent books outstanding in the modern literature of speech science.

Another significant result of telephone research is a series of practical developments such as the artificial larynx, the audiometer, and the apparatus for bringing telephone service to the deaf, as well as the talking motion pictures that have helped to precipitate the present day discussion about the speech of individuals and the nation. That thought can now

be voiced and speeded by wire and radio to distant countries, to ships at sea, and to airplanes in flight is an impressive demonstration of the part that this scientific effort has played and will continue to play in the improvement of speech.

The telephone's scientists say that their pioneering work has just begun. Prophecy must pause when remembering what has already been accomplished in fifty-four years with the principle Bell discovered. It is certain, however, that with each succeeding conquest of the limitations to a free interchange of thought by individuals, the service that transmits speech and the speech that is transmitted will act and react on each other for mutual improvement.

W. P. BANNING

Transoceanic Telephone Service—General Aspects

A paper presented at the Winter Convention of the American Institute of Electrical Engineers in New York City, January 30, 1930.

COMMERCIAL telephone service between the United States and Europe was initiated January 7, 1927 over one radio circuit, using long waves (about 5,000 meters) and with the circuit terminals at New York City and London, England. Two papers [1] were presented at the Winter Convention of the Institute in February, 1928, on the subject of Transatlantic Telephony, and these outlined the situation as it stood then, after one year's experience with this new telephone service.

There has been a rapid and consistent growth in both the scope and volume of this overseas telephone service, which has clearly demonstrated that such service has a permanent and important place in international communications. It is the purpose of this paper to review briefly the changes in the character and extent of the service that have been made since the presentation of the papers referred to and to consider certain general aspects of the service as now furnished.

The initial long-wave radio circuit has now been supplemented by three radio circuits which operate at short wavelengths ranging from approximately 12 to 50 meters and which terminate at New York and London. In addition to the European service, arrangements have been made for establishing telephone service early this year between the United States and points in South America by the use of a short wave radio telephone circuit with terminals at New York and Buenos Aires. These new short-wave systems are discussed in three

[1] K. W. Waterson and O. B. Blackwell. A. I. E. E. Journal, April and May, 1928, respectively.

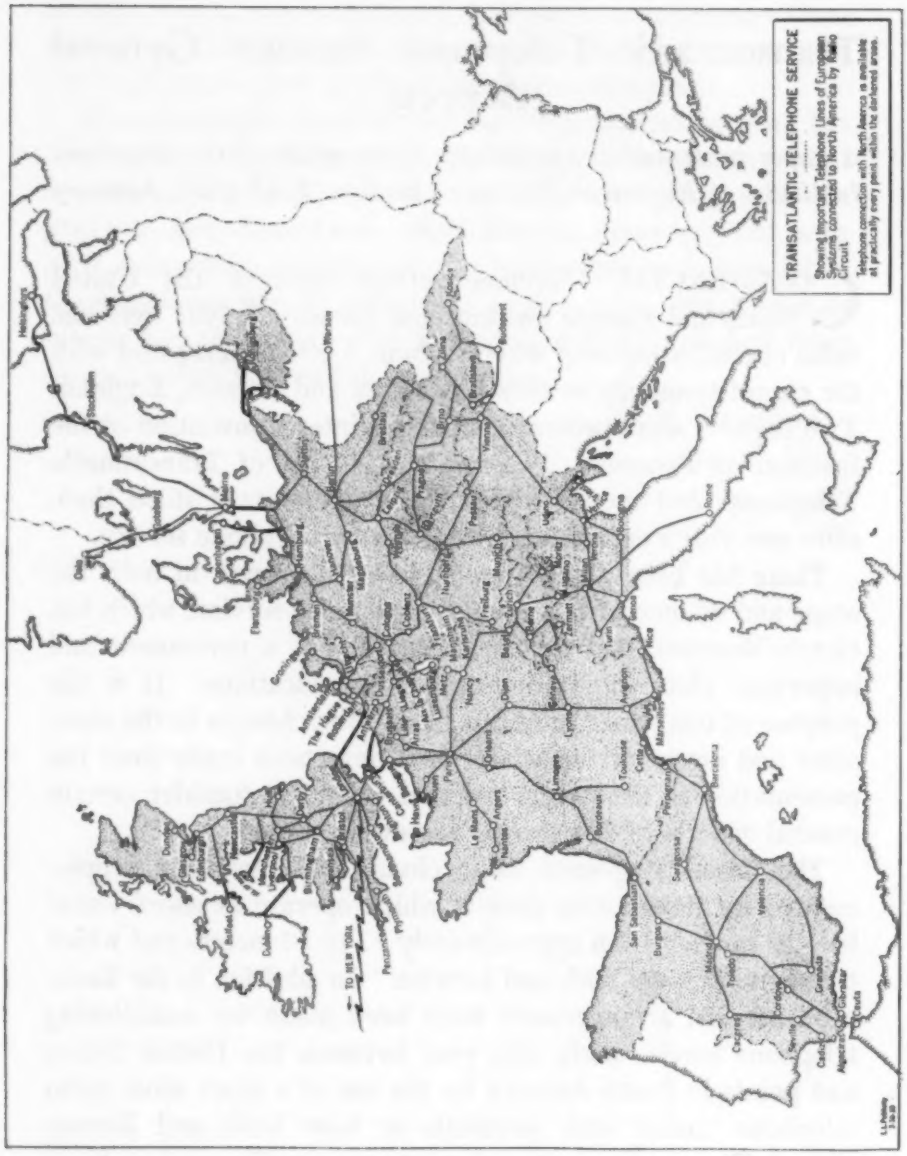

TRANSATLANTIC TELEPHONE SERVICE
Showing Important Telephone Lines of European Systems connected to North America by Radio Circuit
Telephone connection with North America is available at practically every point within the darkened areas.
TO NEW YORK

FIGURE 1

papers to be presented at this meeting by Messrs. Bown, Oswald, and Cowan.

The whole of England and Scotland, Dublin and Belfast in Ireland, most of the important cities and countries in Europe, and one point in Africa, are now within reach of telephone users in the United States, Canada, Cuba, and Mexico. The number of points between which the service is available is continuously increasing, as new points and even whole new countries are added from time to time as the necessary arrangements are made. Very soon after the inauguration of the telephone service between New York and London, this service was made available to telephone users in all parts of the United States. Soon thereafter extensions were made to Canada, Cuba, and Mexico. In Europe the extensions have closely followed the development of the continental connections centering at London, which is still the European terminal of the transatlantic telephone circuits. Among the more important European extensions was the opening of service to France and Germany. The shaded areas on the map shown in Fig. 1 indicate those sections of the overseas world which could be reached by telephone from the United States, Canada, Cuba, and Mexico at the end of 1929. Twenty countries, with a population of about 400 million and with eighty-five percent of the world's telephones, were included within the area served on both sides of the Atlantic. The next major development expected will be the connection to this network of a substantial part of South America by the inauguration of telephone service over the New York-Buenos Aires circuit mentioned above.

For the year 1929, the distribution of the transatlantic calls by countries at the European end was about as follows:

England, 52 percent; France, 32 percent; Germany, 8 percent; other countries, 8 percent.

Although the daily service period was limited at the start by the restriction of the hours for telephone use of the Rugby transmitting station in England, it later became possible to ex-

tend the hours so that in the spring of 1928 the service was available about 10½ hours each business day. As the demand for the service increased and additional channels became available to increase the reliability of the service at times when atmospheric conditions were unfavorable, still further extensions were made in the hours of service. The chart in Fig. 2 shows graphically the changes in the hours of service which have been made. Since September 10, 1929, the service has

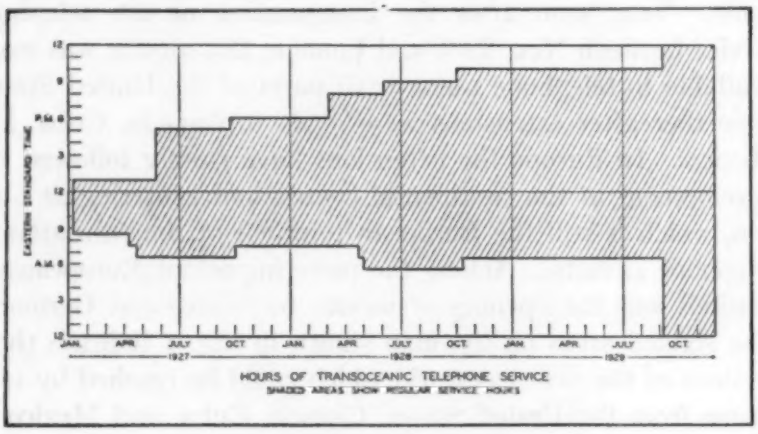


FIGURE 2

been available on a 24-hour day basis. The changes that were made in the hours of opening this service in the morning are due in part to changes in London and New York to the daylight saving plan.

The service is in greatest demand during those periods of the day in which the business hours in America and Europe overlap, although the tendency of this traffic to peak in these hours is not as great as might be expected. It is an interesting fact that even with a time difference of five or more hours, which leaves only a few overlapping business hours, the hour by hour demand for the transatlantic telephone service displays quite the same characteristics as generally comparable long distance

telephone traffic in this country. Fig. 3 shows the distribution by hours of the transatlantic traffic and for purposes of comparison the distribution of other person-to-person traffic originating at New York. The remarkably close agreement may be explained in part by the fact that the usual business hours

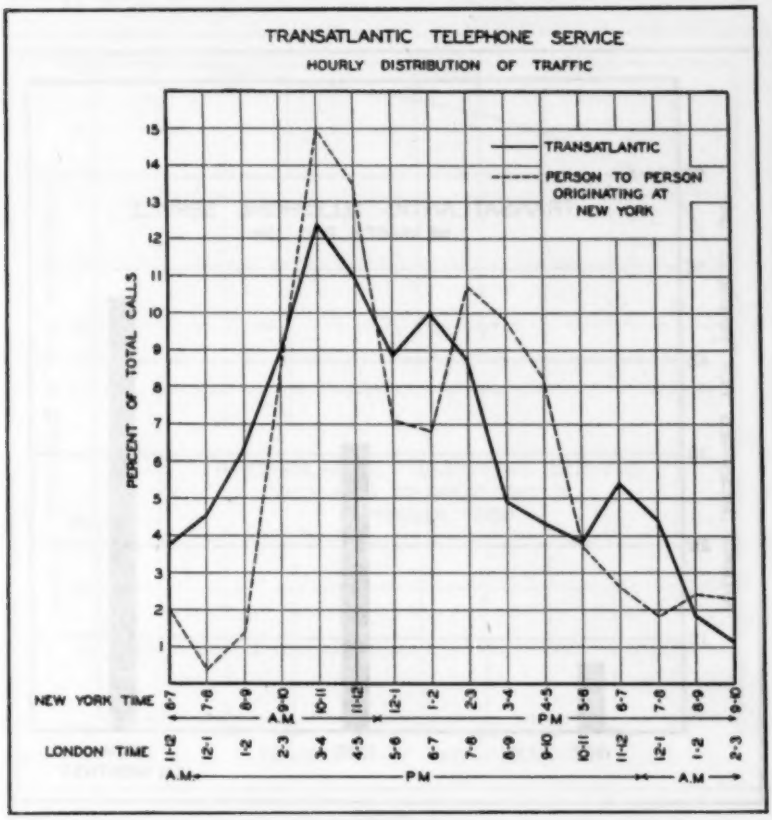


FIGURE 3

in this country correspond to the afternoon and evening in Europe, at which times there seems to be the greatest demand for transatlantic telephone facilities for conducting business and for social conversations.

The basic rate from New York to London is at present $45

for three minutes with slight additions for extensions in Europe or America. The initial rate of $75 was reduced to the present level on March 4, 1928 and this was, of course, responsible for some growth in business. The messages per day, averaged monthly, increased from 13 in February 1928 to 45 in May, only three months after the rate reduction, although part of

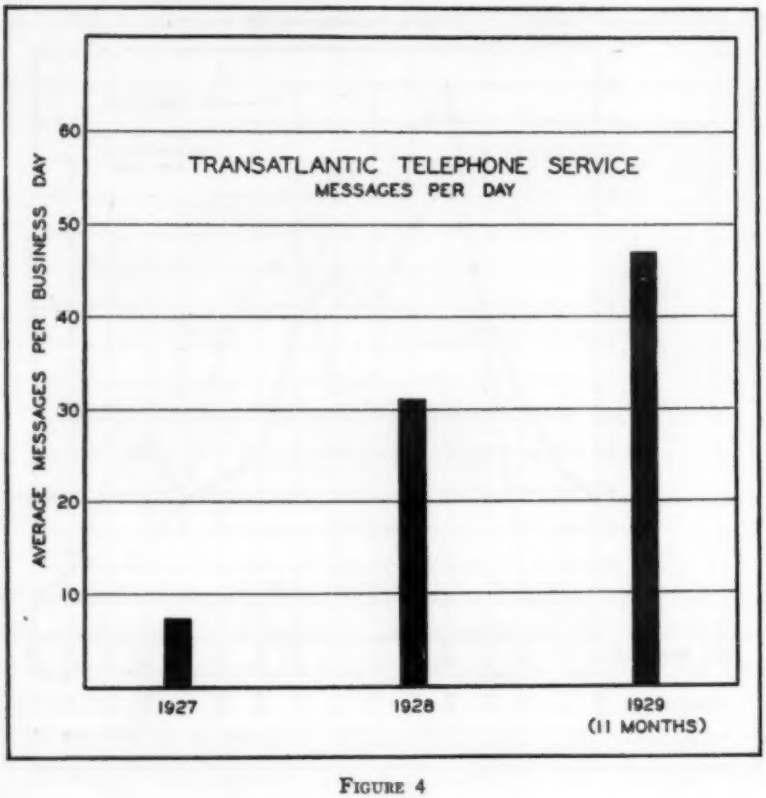


FIGURE 4

this increase was due to additional points reached by the service during this period.

The volume of business offered in the European service has grown rapidly. From a start of only a few messages each day in 1927, it has grown until during 1929 the average was close

to fifty messages per business day. Fig. 4 shows this graphically. The largest number of messages handled in any one day to date was 139. Aside from the seasonal variations which usually result in a falling off of business during the summer, and the drop following the opening due to the falling off of calls placed partly out of curiosity, the trend has shown a consistent

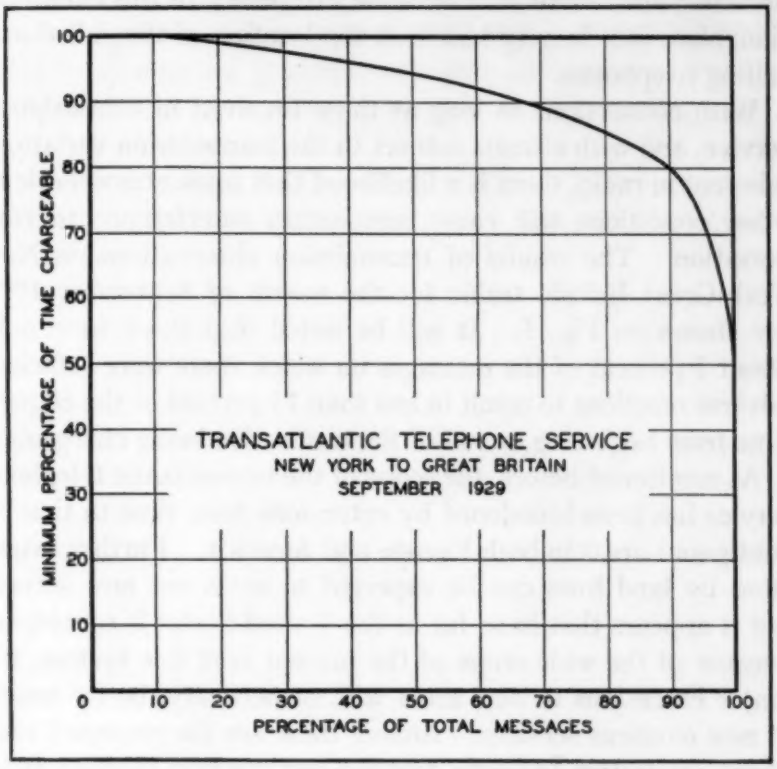


FIGURE 5

increase. Some of the factors contributing to this, other than the changes in rates, are the improvements in transmission and speed of completing connections, the increase in points within reach of the service, the extension of service hours, and an increasing appreciation by the public at large of the value of this service.

As to the nature of the business handled, social calls seem to make up a large percentage of the transatlantic telephone traffic. The actual percentages of the business which may be classified as social, business, or otherwise are as follows:

Social, 48 percent; Bankers and Brokers, 27 percent; Merchants, 4 percent; Miscellaneous 21 percent. It should be appreciated that there may be some inaccuracy in this classification, since it is largely based on the location of the called and calling telephones.

With connections as long as those involved in transatlantic service, and with circuits subject to the transmission variations inherent in radio, there is a likelihood that some atmospheric or other conditions will cause momentary interference to conversation. The results of transmission observations on New York-Great Britain traffic for the month of September 1929 are shown on Fig. 5. It will be noted that there were only about 5 percent of the messages on which there were sufficient adverse reactions to result in less than 75 percent of the elapsed time from beginning to end of the connection being chargeable.

As mentioned before, the scope of the transatlantic telephone service has been broadened by extensions from time to time to contiguous areas in both Europe and America. Further extensions by land lines can be expected to areas not now served, but it appears that in so far as the United States is concerned, because of the wide scope of the present land line system, the major extensions to new areas will, of necessity, be by means of new overseas services. Among these are the proposed telephone connection to South America and the ship-to-shore radio telephone service recently inaugurated. To strengthen further the ties already made, there is a comprehensive program under way which includes a transatlantic telephone cable and a second long-wave transatlantic circuit. Additional short-wave channels to Europe and South America may be added, if required by future developments of the business, and it is to be expected that telephone service to other countries will be estab-

lished from time to time, as may be justified by the requirements for this form of communication.

The technical means to make this possible are now largely available, but, of course, other factors such as economic considerations must be taken into account. While continuous and consistent progress is looked for, the ideal of a world-wide telephone service operating on a comprehensive and commercial basis and with a high degree of reliability is something which must be approached gradually and with patience.

T. G. MILLER.

Telephone Man Power

EQUIPPED with more than twenty million telephones, the American public requires the daily services of more than four hundred thousand individuals to operate and maintain its telephone business.

The ordinary telephone user merely sees a telephone instrument, and (unless he "dials" his number) hears the voice of an operator. Beyond that he gives little thought to telephone plant or personnel. Yet the one telephone that he uses represents but an infinitesimal part of the four billion dollars invested in the country's telephone plant and equipment, all of which must be ready at all times for his service, since no one in the telephone business knows until a particular call is placed which two telephones are to be physically connected in completing the call. Telephone operators comprise nearly one-half of the total telephone personnel, but without the assistance of thousands of other men and women, the telephone business could not have been developed nor could it be maintained.

Much has been written about the size and intricacy of this country's telephone plant and equipment. The present article, however, deals with the man-power behind the telephone,—an army of workers which in single file would take sixteen days of eight hours steady marching to pass a given point.

The Intricacies of the Telephone Business Require Specialization

This has been rightly termed the age of specialization. Evidences of specialization are found in all activities of life, and perhaps nowhere is it more in evidence than in the telephone industry. Specialists have not only been created by the telephone business, but they have created it. In the early

days of the telephone, one man was the general factotum of an exchange. He solicited new subscribers, collected rentals, repaired plant and equipment, served as relief operator, kept books and did anything else his spare time and ingenuity could care for. Such conditions could not exist today, except in the most isolated places. Special workers devote their entire time to each particular part of the telephone business.

Co-operative Effort of Employees

As specialization increases, so must co-operative effort on the part of individual workers increase. Every telephone worker lives not unto himself alone, but blends his efforts with those of many others, who may be located in the same room, across the continent, or even on another continent.

Take the case of the operator. The efficiency of her work is dependent upon the labors of thousands of others. It was necessary first to provide central office buildings, complicated switchboards; to construct and place pole and cable lines; to manufacture and install subscribers' sets and equipment; to design and install thousands of special parts; etc. It is not enough to have something that will work by itself. Bell's original crude telephone, composed of 52 parts, counting all screws, washers and nuts used in its construction, worked. But today there are more than 150,000 different parts used in the Bell System plant, and each part must function perfectly to provide the best and the cheapest service. Thousands of engineers and their assistants are employed today in the Bell System to insure this result. Whereas the operator's work depends upon all this previous work, the continuance of her job and the life of the telephone company depend also upon the concurrent activity of all of her co-workers, none of which is more requisite, for instance, than the work of those employees who maintain the mechanical and electrical efficiency of the apparatus.

Specialization and co-operative effort require proper organization of personnel. This necessity is recognized in the form of organization of the Bell System as a whole and in the organization structure of each constituent company of the System.

Organization of the Bell System

The Bell System, composed of the American Telephone and Telegraph Company and its Associated Operating Companies, comprises only twenty-five of the 8,000 telephone companies of the United States, but constitutes the largest telephone system in the world. It now employs more than 360,000 of the telephone workers of the country. In addition, there are more than 90,000 workers employed by the Western Electric Company and the Bell Telephone Laboratories, companies affiliated with the Bell System.

The American Telephone and Telegraph Company, in addition to providing and maintaining the "Long Lines" which interconnect the territories of the Associated Companies, employs more than 2,600 men and women on its general staff organization whose duty it is to prosecute the fundamental work of research and investigation necessary in the business and to render advice and assistance in general engineering, plant, traffic, operating, commercial, financial, accounting, patent, legal, administrative and all other matters involved in the efficient and economical conduct of the business.

Each Associated Operating Company, however, is highly organized to render the best possible service to the public and functions as a unit within its own territory.

These companies of highly organized workers succeeded the "general factotum" referred to above. As the early one-man exchange grew in size, an assistant was required, at first perhaps a man to attend to the clerical duties of the office. Today, in the Bell System alone, there are more than 65,000 men and women engaged in clerical capacities. These men and

women are not merely clerks; they are specialists in different phases of the business. As a group, their duties are multitudinous. Some may know little of the telephone business, others know much. Their jobs range from those handled by the youthful messenger, to those held by highly trained men and women capable of assisting in the solution of administrative problems.

Needs for Clerical Workers

The number of clerical workers in the Bell System is more than the population of Madison, the capital of Wisconsin. Some idea of the kind of duties that keep so many men and women usefully occupied may be gained by a cursory examination of a few of the clerical functions involving mass production. There are, for instance, more than 11,000,000 bills to be prepared and sent to subscribers each month. For subscribers having "message rate service," it is necessary to obtain the number of calls made from each subscriber's telephone or telephones, and to enter such calls with their related charges on these bills. More than 2,500,000 accounts require such treatment. Then the "toll" and miscellaneous charges have to be itemized, and added to the bill. Over 3,000,000 toll calls are completed each day. The tickets for these calls, which first have to be rated and then sorted by subscriber's accounts, would, if placed in one pile, tower 1,000 feet into the air. One day's business! Also, there are, on the average for each business day, more than 23,000 orders to connect, disconnect or move a subscriber's telephone. Each of such orders requires the preparation of various records in order to convey the proper information to all departments involved as expeditiously as possible. The Plant Department wants to know what changes are to be made in wire facilities, the Traffic Department needs to know what lines are to be cancelled or added on its switchboards, the Commercial Department has to make the necessary changes in its directory listings, the Accounting De-

partment requires information for billing purposes; and so on. Again, on the average, there are nearly two million dollars expended each day by the Bell System in additions to and replacements of its plant. This expenditure involves the smallest as well as the largest units of plant. Each unit must be recorded and priced in accordance with its cost, as a basis for charges to the appropriate fixed capital accounts. Each hour of labor associated with the placement of this material must be carefully summarized and the cost included with its appropriate material costs. Other expenses not chargeable directly to any one job have to be prorated to various jobs on a fair and equitable basis.

Had it not been for the introduction of labor saving devices, such as typewriters, computing machines, addressing machines, toll billing machines, electric card punching and sorting machines, etc., the foregoing work alone could not be done without many times 65,000 people. Other clerks, to mention only a few, are busy with the preparation of the many reports of progress and results needed for supervisory control; with the preparation of reports and statements reflecting financial results; with the preparation of hundreds of reports required by municipal, state and federal bodies, etc.

Scientific Specialists

Each clerk, as mentioned before, is as a rule a specialist in his own class of work. However, more outstanding specialization—because it is of a professional nature—is to be found among employees trained as scientists, lawyers, accountants or engineers. In the latter group especially, there is, in the Bell System, a wide diversity of effort with a corresponding intensity of specialization. The Bell System, including the Western Electric Company and the Bell Laboratories, employs more than 10,000 individuals with scientific or engineering training. Substantial numbers of professionally trained men

specially selected from the graduating classes of our universities and colleges are being added to this staff each year.

Telephone engineering as a science is new. It has largely been built up and fostered by the Bell System. Bell's original patent granted 54 years ago has been succeeded by over 11,000 letters patent owned, controlled by or licensed to the American Telephone and Telegraph Company. No patent granted here or abroad has been overlooked by the Bell System if it promised to add to the efficiency of the telephone art. Engineers in the Bell Laboratories have an opportunity to specialize in their chosen field of science. The physicist is allowed free play to study the laws of electricity and sound in their relation to telephony, to study the action of metals under stress, strain, climatic changes, etc. The metallurgist discovers a new alloy to increase the electrical efficiency of telephone apparatus. The electromagnetic scientist determines new values of resistance, inductance and capacity to build up a modified or new type of circuit to accomplish an additional wonder in the art of telephony. The activities of these scientists have saved millions upon millions of dollars to the Bell System in decreased capital charges and reduced operating costs.

The Wide Range of Engineering Duties

The Associated Operating Companies, relieved by the staffs of the American Telephone and Telegraph Company and Bell Telephone Laboratories of the necessity of conducting fundamental research engineering, employ engineers who specialize in work which has little if any counterpart in the industrial engineering world. Telephone engineering relating to operating methods and practices has naturally been developed by the men employed by the telephone companies during the last half century. As the business grew, it became more and more necessary to have one man or set of men assigned to a particular part of the company's engineering problem. An old

definition of an engineer was given as a man who knew something about everything and everything about something. This definition is generally applicable to those engaged in telephone engineering work. For instance, some men must know everything that is to be known about toll transmission; or about outside plant construction; or about central office equipment; or about fundamental plans, etc.; in addition, they must know something about the telephone business as a whole. Each telephone company has a central engineering department which handles engineering problems of an overall character. In addition, the traffic, plant and commercial departments have their own engineering forces. Traffic engineering deals, among other things, with the problems of force requirements, operating procedure, etc. Commercial engineers deal with the growth of population with its concomitant demand for additional telephone service, determination and classification of rates to ensure the proper charges for the types of service offered to the public, proper types of equipment for varying subscribers' use, etc. Plant engineers have charge of the engineering problems involved in the construction and replacement of plant and equipment, etc.

Staff Workers

Another group of specialists are those individuals who may properly be called staff men. These are to be found in all operating departments. Their work involves the study of operating methods and procedure. Wherever one step can take the place of two, it is the duty of these men to find it and to recommend it for adoption. To be efficient they must have a comprehensive knowledge of working conditions throughout the company's territory. Routines and practices which they have developed have resulted in the saving of vast sums of money in annual operating expenses.

Plant Workers a Large Group

Another large group of Bell System workers is composed of about 80,000 plant men. These men construct the exchange and toll circuits, install subscriber's telephones, make the necessary connections in central offices, etc. They also maintain the plant in repair in order that there may be no interruption in the universal service offered by the Bell System. It is these men who exemplify the spirit of service by going out into the darkest, the stormiest and the coldest nights, when most other workers are off duty, to restore lines that have been crippled by storms or floods. They have as a slogan "The Messages Must Get Through." Plant forces require many types of specialists. One man is an expert cable splicer. Another is a wizard in locating and correcting line trouble. Another man is best fitted for the supervision of pole erection. In fact, such examples might be extended over scores of different plant occupations followed daily in the Bell System.

Specialization does not always imply limitation of activity. For instance, the expert cable splicer of today performs the work which a few years ago required the assistance of a plumber, a wire tester and a transmission tester. Again, a telephone man who enters a subscriber's house to install a telephone has a splendid opportunity to appraise the telephonic needs of the subscriber and to suggest additional facilities, such as extension telephones or wiring plans, which would make the service of greater value.

"The Voice With The Smile"

The army of telephone operators exemplified by the slogan "The Voice With The Smile," deserves more than passing mention. These women, like the plant men, have a deep sense of their responsibility. "Service First" is their ideal. The daily press often contains items about an operator who stuck to her switchboard, while other people fled, in order to

call for help and to warn those threatened by an impending calamity. The operator's duties are exacting and require a high degree of tact and skill. The companies realize the character of the operator's job and provide every practicable means to promote her comfort and wellbeing. The task of operating a switchboard is also highly specialized. There is the "A" operator, who answers the subscriber's signal, the "B" operator, who completes the call in another central office, the toll operator, information operator, complaint operator, relief operator, recording operator, directory operator, etc., all under the direction of supervisors and chief operators. There are in the neighborhood of 85,000,000 telephone calls completed a day, in the United States. If one of these calls goes wrong an operator may be blamed. Who thinks to praise her for all the calls completed without trouble or delay?

Miscellaneous Classes of Telephone Workers

There is a large group of Bell System employees whose work is not so closely allied to telephone operation as is the work of those employees previously discussed. In this miscellaneous group, comprising more than 20,000 workers, are to be found doctors and nurses employed to safeguard the health of telephone men and women; chauffeurs; skilled workers in practically all the better known trades, such as carpenters, plumbers, electricians, machinists, painters, etc.; unskilled workers, such as janitors, watchmen, porters, scrubwomen, helpers, etc.; matrons, having supervision over operators' rest and locker rooms; cooks, waitresses, etc.

The Executive Forces

No organization, however well planned, could function long or efficiently without a head or executive organization. This organization in the Bell System is composed of some 175 men known as general officers and includes the presidents, vice

presidents, secretaries, treasurers, general counsels, general auditors, general managers and chief engineers of the various Bell companies. These men have general supervision of the affairs of a company as a whole. They hold the reins that govern the team work of Bell employees far and wide. Present Bell System prestige has been due to the farsightedness and the splendid work of the men who are now holding, and who in the past have held, these positions. They have made it their business to see that the public was served quickly and well, that employees were treated fairly, and that holders of Bell System securities, of whom there are now about 700,000, received a proper return upon their investment.

Limitations of space forbid an adequate description of the work performed by all telephone employees. An attempt has been made merely to block out a large picture to show the general relation and interrelation of employees and their work. No telephone employee should feel, because his work has not been mentioned or not fully described, that he and his work are of less importance to the company or to the public than that of those mentioned here.

CLARENCE W. FOSS.

Adapting Motor Vehicles to Telephone Work

TRANSPORTATION in the Bell System is handled by 18,500 owned and 4,500 rented automobile trucks and cars. While transportation, of course, is a necessary service rendered by these vehicles, there is an additional, auxiliary service demanded from them which covers an extensive field and is very important. The auxiliary use of the vehicles with power operated, labor saving devices does not interfere in any respect with the transportation function and it results in economies for the user which are often more important than the economy resulting from the transportation service. It is this additional service to which this paper refers.

Since it will not be possible to discuss in detail the many power devices which have been developed within the last few years, and the many others which are now being adapted for use with motor vehicles, only a few of the more important adaptations which have been made and used in the Bell System will be described briefly. The earlier vehicles in telephone service were purchased solely for transportation of telephone construction materials and employees. The volume of work to be done by the gangs associated with these trucks, increased rapidly. The opportunity was presented of assisting the workmen by using the truck engine power with suitable auxiliary equipment to do some of the heavier jobs. The results of these early adaptations were so good that many other developments have been completed from time to time in order to keep this branch of the work in step with the rapid growth of the telephone industry.

Much of the auxiliary equipment which will be mentioned is driven from the motor vehicle engine by means of suitable

power take-offs, from the engine itself, the transmission, or the propeller shaft back of the transmission. The propeller shaft power take-off is, generally speaking, the most suitable for general use.

The general features of this unit follow transmission design although it serves an entirely different purpose. It is so arranged that power can be taken off through one or two side shafts which can be made to operate in either a forward or reverse direction. From the chain-drives out of this power take-off there can be obtained all speeds of the truck transmission. Also one of the take-off chains has reverse as well as forward speeds for the various transmission speeds. Ordinarily when the power take-off is in operation the clutch which is a part of it and which operates the propeller shaft to the rear, is disengaged. However, the design is such that when desired the truck and the power take-off can be operated simultaneously.

The design of this unit permits the chain drive to be taken from either the front or rear of the case and from either side or both sides of the propeller shaft. Of course, where the dual purpose feature is not required, the part of the case carrying the second take-off is omitted.

A power take-off opening on the side of the transmission is employed in some instances. However, it has been found generally that in driving the heavier equipment the flexibility of this power take-off is not sufficiently great. The power is taken from the lay shaft in the transmission so that the various transmission speeds are not available in the power take-off. Because of this and in order to provide some flexibility of operation, a special auxiliary transmission has been designed to fit over the power take-off opening, which gives two forward and one reverse speed. Because of the small size of the standard transmission opening, it is necessary first to bolt an adapter plate to the transmission and then bolt the take-off to the adapter plate.

As this illustrates, even the large standard transmission opening is much too small for many purposes to which it must be applied. Also, there are other difficulties in the use of power take-offs on commercial transmissions. They arise because of deviations from standard practice as regards the power take-off opening and the gear setting which co-operates with it. These non-standard power take-off openings are not any larger, only different. Such non-standard transmissions, of course, present a serious difficulty in the adapting of machinery equipment to the trucks.

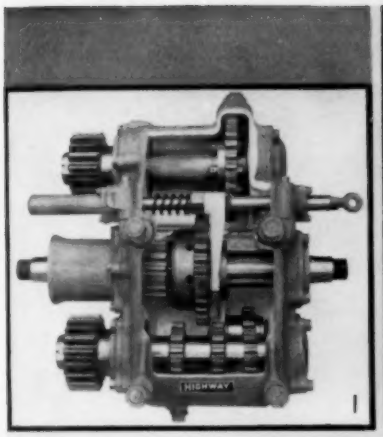
Another type of power take-off is being used at the front end of the motor vehicle engines for certain types of service. Ordinarily this take-off operates at engine speed and is controlled by a jaw clutch. However, there are some installations where it combines a friction clutch with a small transmission.

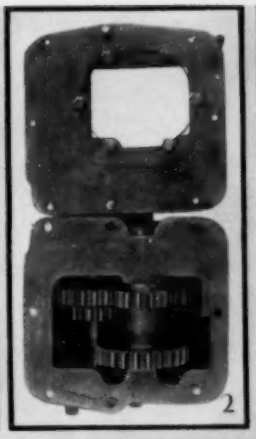
Now that we have studied the power take-offs briefly, let us next see to what this power is applied. One of the most important and broadly used power devices in the public utility field is the winch.

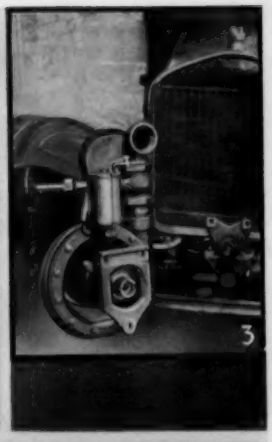
Various types of winches have been developed for the different kinds of service, i.e., oil field work, safe moving, public utility work, etc. In our studies of the truck winch problem from the telephone viewpoint, the desired goal which has been kept in mind, is to provide a unit which will make a single line pull of as much as 10,000 pounds when desired, be light in weight, easy to mount, low in cost, and which will be practically non-reversible except when driven backward by the truck engine.

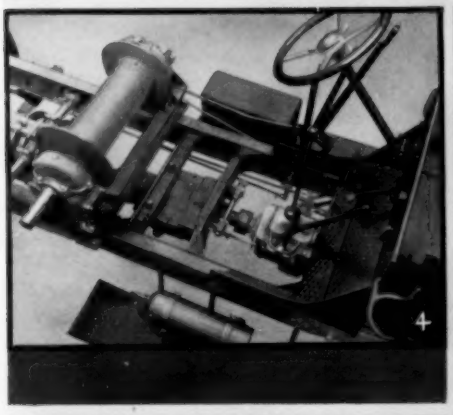
The winches which have been developed for this work are made of steel, and a unit which will accommodate 1,000 feet of 7/16-inch rope weighs about 500 pounds.

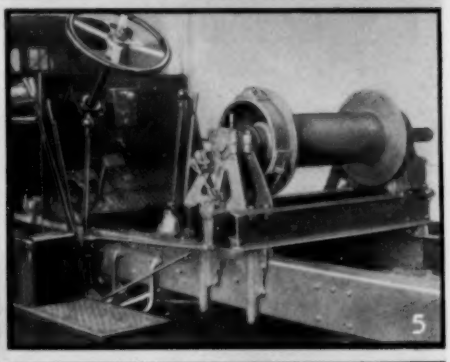
A satisfactory winch mounting is provided by castings bolted or riveted to the sides of the truck chassis frame. The winch rests on these castings and is secured to them by means of four

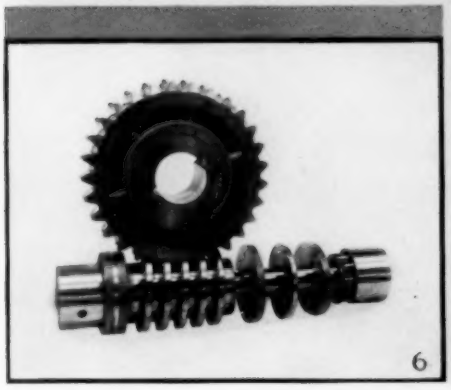


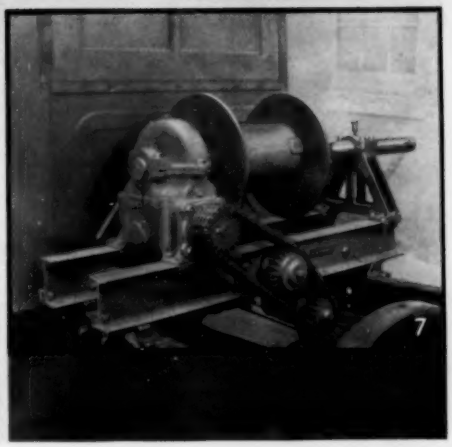




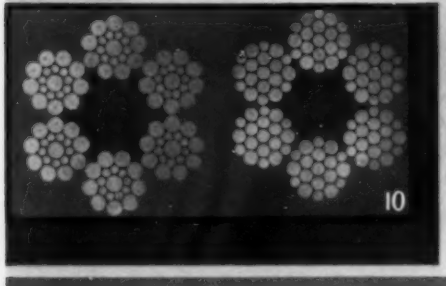


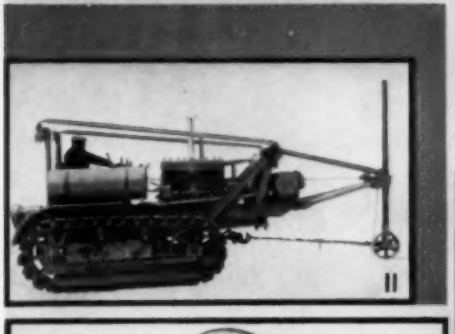






1. Propeller Shaft Power Take-Off.
2. Transmission Power Take-Off.
3. Engine Power Take-Off.
4. Winch Installed with Propeller Shaft Power Take-Off.
5. Winch Mounting.
6. Winch Worm and Wheel.
7. Light Winch Installation with Idler Brake.





8. Pulling Aerial Cable with Winch.
9. Pulling Underground Cable with Winch.
10. Seale and Warrington Lay Winch Ropes.
11. Tractor Cable Puller.
12. Car Unloader.
13. Unloading 5-Ton Reel of Cable.
14. Piking in a Pole.

heavy bolts which can readily be removed in case it is desired to detach the winch.

The worm and wheel are of such a design that within the desired operating range the winch is practically non-reversible. However, on trucks which do not have clutch brakes there is a tendency for the winch to continue to lower a heavy load slowly after the clutch is released, due to the inertia of the driving parts. Where there is a clutch brake it stops the moving parts at the time the clutch is disengaged, and there is no tendency for the load to start down once it has been stopped, until power is applied to the winch in the reverse direction.

For use with winches on trucks which do not have clutch brakes, an automatic brake has been developed. This automatic brake is incorporated in an idler sprocket arrangement which can also be used for tightening the winch chain.

Some of the earlier winches were driven by means of roller chains, but now silent chain is used because of the high chain speeds required to produce adequate rope speeds when driving through a non-reversing worm. The rope speeds required in telephone work vary from 50 to 300 feet per minute.

The steel rope which is ordinarily used on the winches varies in size from 5/16 to 7/16 inch, depending on the condition of service. The type of rope most generally used consists of six strands of 19 wires each, built around a hemp core. The breaking strength of the 5/16-inch rope ordinarily used is about 9,000 pounds and of the 7/16-inch 13,000 or 19,000 pounds, depending upon whether the material is crucible cast steel or plow steel.

It might now be of interest to see some of the services to which the winches are applied. The suspension strand which carries aerial cable is placed at tensions varying between 1,000 and 6,500 pounds. By using the winch to apply the tension to the strand, the work of placing it is done quickly and by virtue of the very accurate control of the winch, the pull can be made to exactly the desired tension.

After the aerial cable strand has been placed it is necessary to pull the cable, which varies up to 1,000 feet in length, into the rings suspended from the strand. This is ordinarily done by means of the steel winch rope. With this set-up the cable is pulled in at the rate of from 100 to 250 feet per minute, depending upon the conditions.

Where it is desired to place the telephone cable in underground ducts, it is pulled by first feeding the winch line into the duct, then attaching it to the cable end which is fed in from a reel located at the end of the duct line away from the winch. In order to prevent excessive wear in the winch line, when pulling through ducts, a type of steel rope designated as Seale Lay is used.

The outer layer of wires in the six strands of a Seale Lay rope are heavier, which results in such a rope withstanding abrasion much better than the usual Warrington type of rope in which the wires are of smaller diameter.

Some of the underground cable between cities is now being placed in duct lines which leave the highways and cross private right-of-way. For pulling in cables at such locations a special device has been developed for use with a winch on the front end of a caterpillar tractor. The wheel of this pulling outfit can be lowered into a manhole or trench and the pull made in line with the duct.

Whenever a heavy handling job arises in telephone work the first thought is to make some adaptation whereby the job can be done by means of the truck equipment. The illustration shows an example of such a case where 5-ton reels of cable must be unloaded from cars at railroad sidings, under conditions which require that all work be done from one side of the car. A framework with suitable tackle is attached to the track so that the winch line can be led under the car and up on the side opposite from the truck. The end of the winch line is attached to a yoke which holds back on the reel as it is lowered to the ground over heavy skids.

In the public utilities throught the country a very large volume of pole work is done. In the Bell System alone more than 1,000,000 telephone poles are set per year. These poles weigh from 1,000 to 3,000 pounds each and they are awkward to handle by hand methods.

With the winch and derrick combination even the largest poles can be set in their holes easily by a very small gang of men. Where it is necessary to maneuver the top of a pole through tree limbs or existing wires the operation is greatly facilitated and is much improved from a safety viewpoint, since the load can be lifted and lowered a few inches at a time by means of the truck winch. In pole handling particularly, the non-reversing feature of the winch is of prime importance. If it is desired to stop a pole at any point in the process of raising it, this can be done merely by throwing out the engine clutch. The pole then stays in a fixed position until it is either again raised or lowered by applying power from the truck engine to the winch.

The derricks are very light for their lifting capacities, being made of high strength seamless steel tubing. A derrick can be taken down from its rack on the truck and erected ready for work in a few minutes by two men.

For some classes of work it is desirable to have a pole derrick which can be raised and lowered by means of a boom line while the lifting and lowering of the pole is accomplished by the fall line from another winch drum. This has led to the development of a double drum winch, each drum of which can be operated independently. The winch, of course, is driven by a multiple power take-off.

In the winch operations, it is often necessary to wind as much as 1,000 feet or, in some cases, even 3,000 feet of rope on a winch. Unless the rope is guided on the drum, it has a tendency to pile up at one end of the drum and cause trouble in the winding operation, not to mention other difficulties which arise in unwinding the rope due to some of the outer

layers having been pulled into the unevenly wound rope underneath. In order to overcome these difficulties, a winch rope winder has been designed which is driven from the drum of the winch.

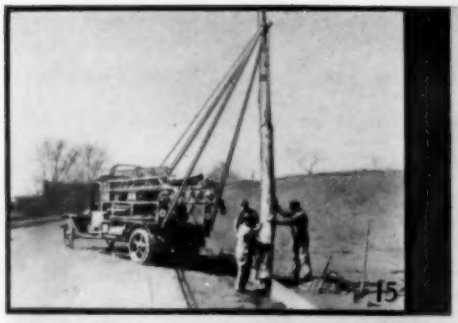
It is necessary to take the drive from the drum rather than from the winch spindle in order that when the drum clutch is released and the spindle operated independently the winder also will be released. A cam and follower move the winder carriage back and forth across the front of the drum at the proper speed to handle the size of rope being used, and the follower is so designed that it functions properly even though the rope pull is up or toward one side at a considerable angle from directly back of the winch.

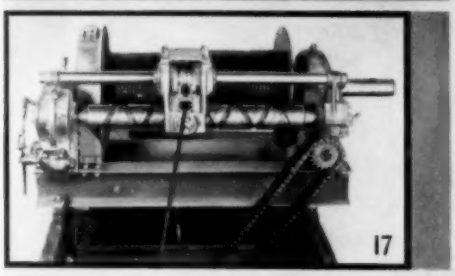
Another feature of the winch rope winder is an automatic brake which puts a slight tension in the winch line when it is being reeled on the drum without a load on the line. When there is a pull on the line this automatic brake releases itself so that there is then no wear on the winch rope due to it.

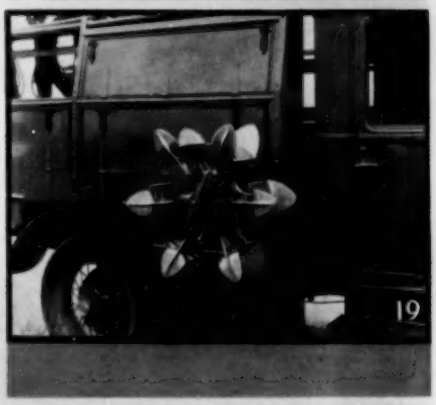
When it is necessary to take down telephone wire from the crossarms, it is desirable to roll it into coils weighing 100 to 150 pounds each in order that the junk wire can be easily handled. A collapsible power reel has been devised to do this work. The reel shaft fits over one end of the winch spindle and has a bayonet joint so that it is easily attached and removed. When the wire has been coiled on the reel and bound, a lever is turned on the end of the reel spindle, quickly collapsing the reel and releasing the coil of wire.

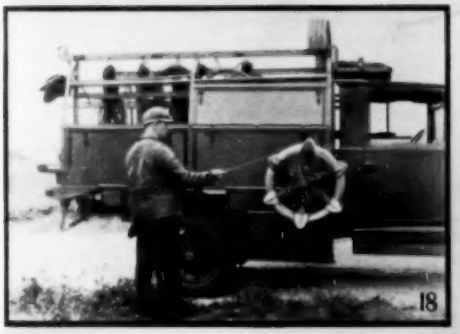
This collapsible reel is adequate for pulls up to about 3,000 pounds which permits its use to some extent for cable pulling and certain other classes of work, in addition to taking down wire.

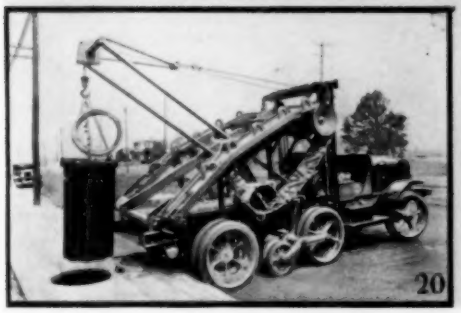
The loading of telephone poles upon trailers for delivery is another job for the power equipment. Regardless of the size of the poles, two men and the truck driver can easily and quickly load the trailer from the car or pole pile, secure the



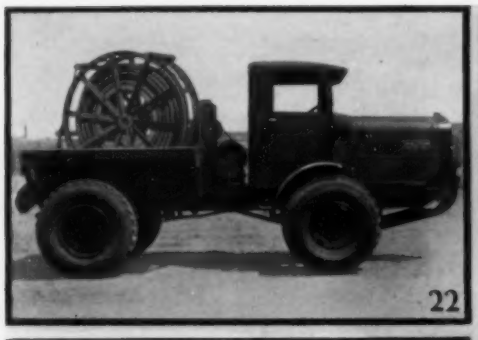


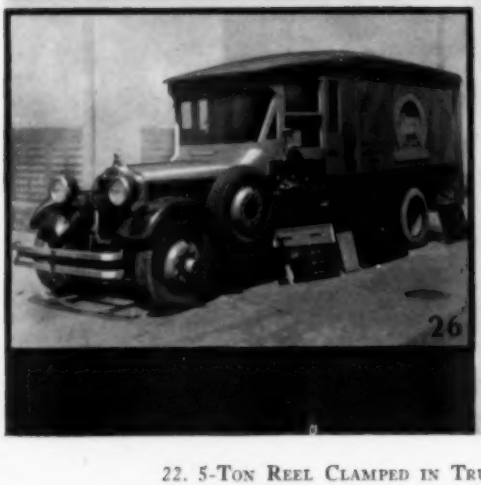


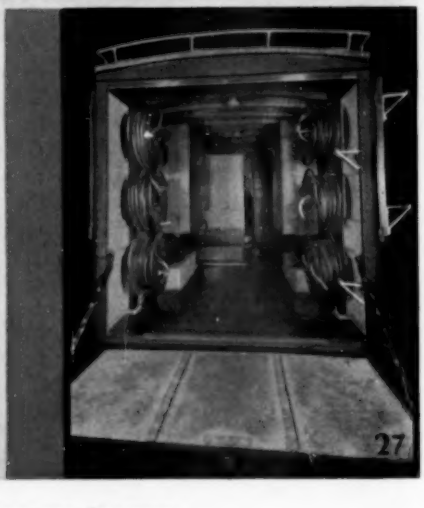




15. Erecting a Pole with Tripod Derrick.
16. Erecting a Pole with Telescoping Derrick.
17. Winch Rope Winder.
18. Collapsible Reel Operating.
19. Collapsible Reel.
20. Handling Loading Pot.
21. Loading Reel.







22. 5-Ton Reel Clamped in Truck for Delivery.
23. Self Priming Centrifugal Pump on Truck.
24. Earth Boring Machine Operating.
25. Earth Boring Machine with Auger Set at an Angle.
26. Engine Driven Generator on News Reel Truck.
27. Rear View of Body on News Reel Truck.

load on the trailer and connect the unit to the towing hook at the rear of the truck, thus completing the job in the pole yard.

Another heavy handling job in telephone work is presented by the loading coils in large iron cases, which resemble electric light transformers. Special derrick equipment has been designed for lifting these cases to any desired location on the truck platform, and, of course, they can be unloaded by reversing the operation. While the power is derived from the winch lines as in pole derrick operations, the derrick must necessarily be of a different type. It will be noted that the truck upon which this derrick is mounted carries removable tracks which permit it to operate over soft ground.

The large reels of cable used in telephone work are transported on trucks or trailers. In loading a truck, wherever practicable, the heavy reels are drown up directly over the rear of the truck platform without the use of skids. This is accomplished by means of a sling attached to either side of the rear end of the platform, passing around the reel and hooked to the winch line.

When the reel has been pulled up into the truck body the same sling and winch line hold the reel in position during transportation. This method of securing the reel in the truck is much superior to merely chocking it front and rear because the sling not only prevents fore and aft motion of the reel but exerts a considerable force to prevent overturning which might occur in turning corners or while the truck platform might be tilted to one side.

The illustration shows a new type 100 horse power, four wheel drive truck equipped with 44 by 10 inch pneumatic tires with duals in the rear, and it is remarkable the ability it has demonstrated for negotiating hills, soft sand and mud.

Where excavation work is in progress and in manholes where cable splicing work is to be done, it is often necessary to remove large volumes of water quickly. A reliable unit for this class of work is a centrifugal pump driven from a power take-

off at the front of the motor vehicle engine. Such an outfit will handle about four barrels of water per minute. This unit has the advantageous features that it is extremly portable, has a high capacity for its weight and size, and is very reliable since the power plant from which it is driven should always be in an operating condition.

This particular type of pump has an interesting priming device. There is a connection from the pump to the intake manifold of the vehicle engine, which exhausts the air from the suction hose line and pump, thus providing automatic priming for the outfit.

Preparatory to the erection of telephone poles, it is necessary to dig holes which are from 16 to 24 inches in diameter and from four to eight feet deep. Due to the small diameter as compared with the depth of these holes, it is difficult to dig them by hand even in fairly soft ground. Where hard-pan, shale, sandstone or field stones are encountered, the digging operation becomes much more difficult. Because of the large number of poles erected, this digging operation is a very important factor and in order to expedite the job and lower the cost of the construction work, earth boring machines have been developed. The one illustrated is operated from the truck engine and in a few minutes it will dig a hole which would require several man-hours to do by hand. By means of the two levers at the rear of the truck the operator can spin the auger and raise or lower it as desired in boring the hole.

The mechanism is enclosed within an oil tight case and is so designed that the rack bar has universal motion which permits the operator to set it for a hole at a considerable angle in any direction from the vertical. The boring mechanism which is mounted on the rear platform of the truck weighs about 2,000 pounds and can be removed from the truck by two men in about one-half hour, leaving the truck platform free for other service.

One of the latest adaptations of motor vehicles to special

service has been the development of the Movietone outfits for making talking movie news reels. These units derive their power from generators driven by the truck engines, charging the storage batteries which are used in the operation of the equipment.

The bodies of these outfits are designed with compartments for the various units of equipment. At the rear are quick acting reels carrying insulated wire which can be paid out to any location where it is necessary to take a film at a point which cannot be reached by the truck. The entire equipment of the outfit is designed for maximum convenience and reliability in operation.

In this paper it has been sought to bring out the field of usefulness for auxiliary power equipment with the motor vehicles. The development of this field has been recent and is gaining momentum as time goes on, so that at present a great deal of new work is being done. In connection with these developments there is close co-operation with the engineers and manufacturers of motor vehicles in the designing and building of their trucks and cars so that a minimum of difficulty will be encountered by the users in adapting the power equipment to the vehicles, and so that a complete outfit when ready for the job, will represent a unity of good design from the viewpoints of cost, utility and appearance.

T. C. SMITH

Office Standards and Costs as Applied to Public Utilities

A paper presented to Rochester Chapter, National Association of Cost Accountants, December 9, 1929.

In addressing a group such as this, I assume that it is wholly unnecessary to first establish the premise that in almost every line of commercial activity cost information is a valuable aid to management. That premise, I take it, is already accepted. Certainly there is today a universal realization by management of the need for cost information. Not only is there that realization, but there is a growing demand that such information be available *before* the fact rather than *after* the fact.

The function of the telephone business, and perhaps of most public utilities, that requires more clerical workers than any other function is that known in the telephone business as revenue accounting and commonly known as customers' accounting. It comprises that branch of the Accounting Department which is responsible for preparing and rendering bills to customers and maintaining their accounts. The centralization of this work exclusively in the Accounting Department as a direct responsibility of the chief accounting officer is perhaps a different allocation of the function than prevails in most public utilities.

It is my purpose to tell you this evening something of the philosophy of our approach to the problem of office standards and costs and to indicate how the consistent application of this philosophy has enabled us to realize in a large measure, a standard of performance which is most gratifying although still subject to progressive improvement. In order to crystalize the discussion, I have attempted to put into three simple

words the whole basis of our philosophy. These three words are centralize, standardize and specialize.

One of the definitions of centralization is this—"to bring to a central point; bring under one system of control." Some years ago, our customers' accounting was not centralized but was decentralized in the numerous public business offices of the several companies and, while broadly speaking it was under one system of control, the difficulties of standardizing practices under the decentralized arrangement were quite serious. Furthermore, few of the offices had a sufficient volume of work to make possible the effective application of the principles of scientific management or to justify the purchase of labor-saving devices. We concluded that without centralization there could be no satisfactory progress toward standardization and specialization; and that without the application of these fundamental principles, the standard of performance, both as to quality and quantity, could not be raised to the high plane which we held as an objective. We therefore set about to centralize our customers' accounting work into units that would concentrate in one place a sufficient volume of work to keep a number of clerks continuously engaged on the same operation. The determination of the size of the units was necessarily influenced by the consideration of geographical lines, mail distances, operating organization, and other factors. By the end of 1920, centralization of our customers' accounting into relatively large units had been substantially completed. Summarizing briefly our experience in connection with centralization, it can be stated that it has enabled us to adopt to an unexpected degree many labor-saving devices, some of them of such capacity that they could not possibly be justified without centralization; that it has enabled us to more readily study and standardize practices; that it has created a more flexible organization, less susceptible to disorganization by reason of labor turnover and conditions resulting from absences. In other words, it has cre-

ated a condition of mass production under which the principles of scientific management can be most effectively applied.

The next step in our philosophy is standardization. The word "standardization" sometimes has an irritating effect. It is not quite so obnoxious as the term "efficiency expert" has become in the past few years, but yet it carries a somewhat foreboding inference. In these times of mechanized activities of every kind, the use of the word "standardize" in some of its implications and, unfortunately, in some of its applications may create the fear that all of the initiative, individuality, originality and human skill is to be erased from our several jobs and that industrially, at least, we shall become mere robots. My conception of standardization, as applied to office work, falls far short of any such disagreeable outcome. In my opinion, standardization as applied to office work should have as an objective a uniform product of high quality based on proved practices. Another objective should be that of enabling the management to make comparisons. Without standardization, comparisons are most difficult and unsatisfactory if at all feasible. Analyzing the question of standardization further, I should say that the lack of it prevents effective management. It is especially advisable where the same work is being performed at different locations under different supervisory direction. The Bell System issues about 12,000,000 customers' bills each month from about 100 accounting centers scattered over the United States. In respect of that work the general staff in New York concerns itself with standardization of the fundamental practices involved in the performance of the work and the standardization of the mechanical devices and equipment. For example, after the centralization of the work had been accomplished, the next fundamental standard practice adopted was the so-called "accounting stub" plan, under which the customers' ledger or ledger cards were entirely displaced. The plan is widely used by public utilities, and I believe that it is applicable under any periodic billing

where 60 percent or more of the bills are paid as rendered and where there is little need for reference to the accounts for previous months.

Following the general adoption of the accounting stub plan by the Bell System companies, the next fundamental change was the adoption of rotation billing or cycle billing. Prior to the use of this plan, all customers' bills were released on the first of each calendar month, which in view of the great volume involved created a tremendous peak load in our customers' accounting.

While the plan of rotation billing was being standardized and before half of the System had adopted it, billing machines were developed and standardized which entirely eliminated handwritten entries on our bills. In the meantime, we had standardized on a specially constructed typewriter for itemizing the charges for toll messages of which the Bell System bills nearly 85,000,000 per month. The standardization of these fundamental practices and of the equipment used necessarily carried with it standardization of a number of related practices.

Before leaving the subject of standardization, I should like to say a word about another aspect of it. Standardization does not just happen—it is not a matter of chance—it is a manufactured product—the result of thought. The staff having the responsibility for designing the standard practices should have among other qualifications that quality which someone has called "constructive imagination." I like that phrase. It expresses exactly that quality of thought which means practicality in new ideas. It means true progress. Such a quality is a great asset in almost any business capacity and especially so to one who is responsible for the development of new and better ways of doing things which constitute the daily activity of thousands of employees.

After a new practice has been conceived, the specifications must be written; but that is not all. Merely writing a stand-

ard practice does not as a rule standardize anything, especially if those to whom it is issued are free agents of an autonomous organization and not merely subordinates. If the practice you wish to standardize is to be accepted by the organization with that spirit of co-operation which is so essential for its successful application, the idea must be sold to them and not merely issued to them.

If a substantial part of the work to be done is susceptible of machine application, the most effective way to standardize the related practices and also the finished product is to standardize the mechanical equipment with which it is produced; that is, put the job in a straight-jacket and not only the job itself, but many of its associated activities, must necessarily fall into a standardized practice.

We come now to the third step in our philosophy of office standards and costs—specialization. Generally speaking, specialization is largely dependent on standardization. One of the important advantages of specialization is the relief it affords in training clerks and supervisors for the job. Another important result of specialization is the improved quality of the product. A clerk will quickly learn to do one thing and do it well, whereas if combination jobs are necessary it is generally found that some of the elements of the combination are of such a nature that they require particular qualifications which may not be required on that part of the combination job which consumes the greater part of the clerk's time. Specialization of detailed assignments also permits of specialized supervision. The practicability of assigning the work of many of the jobs on a random basis is a desirable outgrowth of specialization. The term "random assignment" as applied here refers to the plan of assigning work to the individual clerks in a specialized group on a priority sequence basis rather than to have each clerk handle a fixed assignment, such as certain alphabetical or numerical sections of the work.

A further advantage of specialization is that it simplifies the

setting of wage rates. When combination jobs prevail, it is most difficult to set satisfactory rates since the component parts of the job are not easily weighted. In some cases, the work which requires the least dexterity and the smallest proportion of the clerk's time requires the highest degree of intelligence. That kind of work commands more compensation than the other, but it is on the basis of the highest qualifications required that employees expect to be paid. Specialization eliminates this difficulty and enables us to place a round peg in a round hole. Specialization in detail and in supervision does not lessen the recognition of dependence on other functions or specialized activities. Neither does it lessen responsibility to the management. If there is a proper co-ordination at each level of the organization where such co-ordination is necessary to merge the specialized activities into a well defined and smooth running production mechanism, the question of dependence and responsibility will be met.

I have not overlooked the fact that the subject includes the question of costs. In fact, what I have already said, while not addressed directly to the question of costs, underlies the whole subject of costs. Let us see how the fundamentals of centralization, standardization and specialization affect costs.

Centralization into large units makes it possible to avoid duplication of supervision, to more readily make studies for the standardization of methods, to use mechanical devices more extensively and more economically, and to set up competitive records between individuals and between offices engaged in like operations. Furthermore, without centralization as a first step standardization and specialization are very much restricted, if at all possible.

Standardization of practices makes it possible to more readily measure performance in the terms of cost. This has been well stated recently by W. H. Leffingwell, the office management specialist, who says "Measurement is the first step towards efficient management. Without it, there can be no com-

parison; without comparison the efficient cannot be distinguished from the inefficient." Centralization and standardization are the basic principles back of proper costs since centralization, in addition to effecting other economies, leads to standardization, and standardization leads among other things to measurement. As soon as measurements are possible and comparisons are made, whether it be of one individual with another or of one office with another, differences in production will be found which need investigation, and if investigated constructively will surely disclose a number of interesting and significant facts. Whatever is disclosed by investigation is sure to provide a basis for intelligent action, and if that spirit of progress is sustained which is so essential to success the results will be reflected inevitably in lower costs.

The desirability and necessity for measurements if effective management is to be realized is not a mere theory. Many of the instances of tangible results which have come to light would not have been definitely known without production measurements of office work.

What is the psychology back of these records? What is it that induces clerks to so conscientiously apply themselves to their work that they succeed in shattering our normal expectation of production? We are not on a piece-work basis. There is no whip-snapping and slave-driving supervision. We do not pay bonuses, although production and accuracy are factors considered in determining the amount and frequency of salary changes. I have given considerable thought to this question, and the only solution I can offer is that there is in most human beings a desire to excel their fellows; a desire to win that is stirred by competition in a contest involving skill and accuracy. In a game like this the score could not be adequately focused without measurements of performance. Without measurements of performance the rating of the various clerks is usually based on the opinion of the supervisor, and however impartial and conscientious the appraisal may

be it is still an opinion. Measurement results expressed in figures and based on intelligent analysis and study of the work to be done are recognized and respected by employees as a far more accurate and impartial umpire than mere human opinion.

Specialization offers relief in training both clerks and supervisors. That, of course, directly affects costs. Certainly any scheme that will reduce the training time and bring these workers to a productive basis earlier than the commonly used combination assignment is worthy of consideration and will have a direct effect upon costs. But there are other ways in which the effect of specialization is reflected in costs. One of these is in the fixing of wage rates. It is clear that by breaking jobs down into their component parts, and by teaching only one operation or two or more similar and closely co-ordinated operations to each clerk, it is possible to appraise these several elements separately as to the degree of intelligence or dexterity each requires and to fix rates accordingly. To the extent that proper distinction may be made in the wage rates paid for different grades of work, to that extent specialization will contribute to the reduction of costs. Specialization also provides an opportunity through grading the several component parts of the entire clerical function to offer to the clerical employees the incentive of promotion with the increased compensation which usually follows each step.

Another channel through which specialization contributes to lower costs is that it unquestionably makes more simple and more accurate the determination of quantitative production standards. These standards, furthermore, are higher than they could be if job assignments were made in combination, since it is quite evident that a clerk having one specialized class of work will become more proficient in that work than would be the case if the job assignment included several kinds of work. Furthermore, the time lost in changing from one kind of work to another will be reduced in the ratio that the

number of different kinds of work in each job assignment is reduced.

I have tried to show that the three important steps I have been discussing, centralization, standardization and specialization, have a vital effect on costs. Indeed, they are the foundation stones which must be laid if substantial progress is to be made, first to analyze costs and then to improve them.

Thus far I have dealt with principles and a few specific illustrations of their application to the problem of office standards and costs. These things, however sound and logical they may be, are elusive and ephemeral unless they produce results and these results are brought to a focus in a form that is tangible and readily comprehended.

We realized the importance of having an instrument of management which would bring the whole picture of results into focus and which could be used to further advance the evolution of our customers' accounting. The important instrument needed was a results report which would reflect the performance of our work in the terms of production and cost. While each of the major changes, such as that from customers' ledgers to the accounting stub plan, from first of month billing to rotation billing, and from manually prepared bills to machine prepared bills, was studied prior to its adoption and indicated either some economies or better customer service, or both, we felt that we should have production and cost data currently if we were to get an adequate measure of the results which these major changes accomplished.

When we undertook to construct the measurement report which seemed to be desirable we realized that if a beginning could be made on a report which would paint a picture in very broad strokes and even though not exact would be indicative, we could then gradually refine it as the broader picture revealed to us where such refinements were most desirable. We also had as an objective a report which could be prepared

currently without the necessity of keeping continuous time records. We determined, therefore, to have a time and cost study for a representative month embracing a complete cycle of work.

When the reports of this study were received and summarized and the time factors determined for each operation for each office, we found some very wide discrepancies but we were able from this mass of cost data to set up what appeared to be reasonable performance schedules for each of the operations. A standard of production was established for each classification representing the amount of productive work that should normally be performed in one hour. This "normal" was set for each operation by determining the average performance of the offices having in the aggregate 50 per cent of the total volume and showing the best performance. There were, of course, a number of items which did not lend themselves to the establishment of production units and these we termed "Unmeasurable Work."

From the reports which are received each month, we set up a series of charts, the important ones being the number of units performed per hour and the equated cost per unit of work. We also set up certain supplemental charts. The issuance of these charts introduced the element of competition between the several companies and offices. The result was that the general production average for the entire System began to show an upward trend. There have been a number of refinements made in the report, including the establishment of new standard production units based on a subsequent study and on special consideration of individual operations, and it is interesting to note that in spite of a general tightening-up of the normal production unit the last issue of the reports showed a general average of production higher than that shown by the first reports. Furthermore, there has been a consistent trend to lower unit costs in spite of a general upward trend in the average wage payments.

In the development of our measurement report, we had a secondary objective and as our experience grew the secondary objective became almost as important as the primary objective of making comparisons and fostering competition. That secondary objective was to foster a more rapid acceptance of recommended standard practices. The measurement process had a more vital effect on standardization than we had supposed. In establishing our production standards, we necessarily took into consideration the routine methods under which that production standard could be attained. Therefore, the measurement report not only fostered competition but it also proved to be a powerful incentive for the adoption of the recommended standard routine methods that would enable the offices to reach the production standards set up on this report. Our measurement report has done more perhaps than any other one instrumentality in connection with our program to bring about the degree of standardization on customers' accounting work which has been realized by the Bell Telephone System.

Now I would not have you think that we consider this report as a substitute for management. Such reports are not in themselves an objective—they are a means to an end. Reports can never supersede management, but they can be invaluable as an aid in helping executives to do a better management job.

One of the principles of management is that responsibility and authority should be accompanied by strict accountability for results. This strict accountability cannot be intelligently enforced either individually on the clerks or collectively on the office and its management if it is based solely on human opinion. There must be some impersonal umpire in the form of records and on the basis of these, plus an intelligent appraisal of other factors, such as personality, appearance, etc., a capable and contented personnel can be achieved. Measurements of performance, especially those which are intended to measure

clerical performance, cannot be precise, but so long as they are not misleading they offer a very effective means for indicating to management the weak spots where some corrective measures should be applied. To some extent, the caliber of the management may be determined on the basis of the use which is made of management reports. If an adequate report of results is constructed so that the picture presented may be correctly read and properly interpreted, and if the management uses it intelligently, the information developed will be a compass by which the supervision may steer a course toward greater efficiency in production and greater effectiveness in methods and management.

F. R. BREWSTER

Recent Developments in Toll Telephone Service

A paper presented at the Great Lakes District Meeting of the American Institute of Electrical Engineers in Chicago, December 2, 1929.

THE term "toll" is applied broadly to telephone service between different localities as contrasted with "local" service which is, in general, within one municipality or center

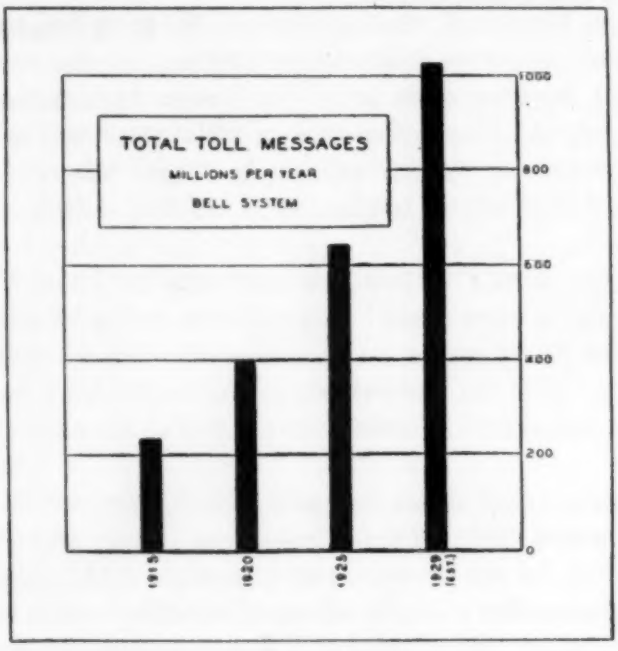


FIGURE 1

of population. From the early days of the telephone business the growth in toll service has always been rapid. This growth has, however, been particularly marked during the last few years. It is the purpose of this paper to outline

briefly some of the plant design and other engineering problems associated with the present rapid growth of this service.

Magnitude of Growth

The growth of toll telephone business is illustrated by Figure 1, which shows the telephone toll messages per year in the Bell System for a number of years. This growth is perhaps more strikingly shown by Figure 2 which shows in terms of

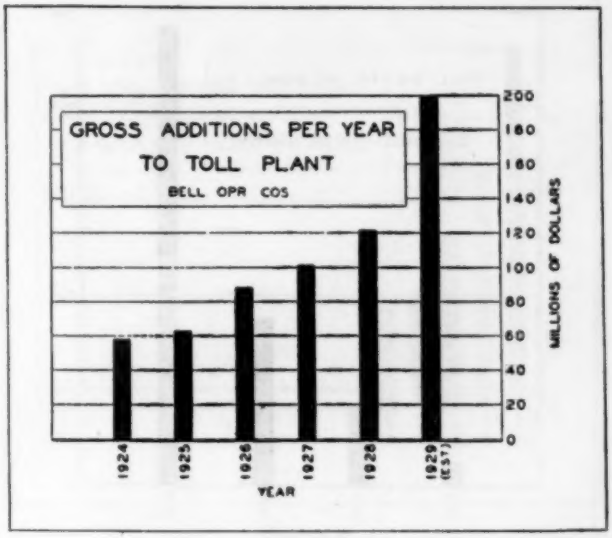


Figure 2

cost the gross additions to toll plant per year for the last few years and the estimated expenditures for 1929. It is to be noted that not only is the percent increase very rapid in comparison with that of past years, but it is expected to continue at a very rapid rate.

A remarkable feature of the increase in the toll business is the fact that the largest increases are being felt in the very long distance business, particularly on the transcontinental routes and the routes between the largest cities in the various parts of the country. Figures 3 and 4, for example, illustrate

respectively the growth in toll messages over a period of years between Chicago and New York, and between Chicago and Los Angeles, which routes are typical examples of this growth. Figure 5 shows the growth in messages for the combined toll business over the transcontinental routes between Chicago and New York and Los Angeles and San Francisco over the same period. It will be noted that while the toll business in the

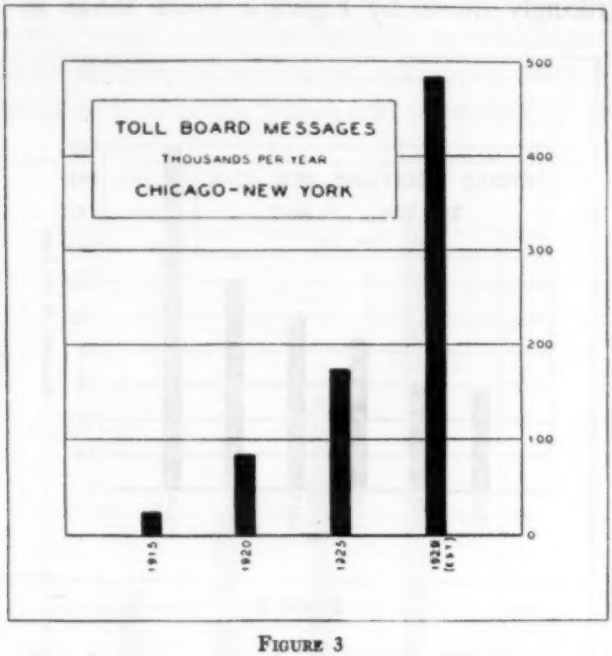


FIGURE 3

system as a whole has increased 34 percent over the last 3 years, the toll messages between Chicago and New York have increased about 115 percent, the toll messages between Chicago and Los Angeles 157 percent, and the combined transcontinental business 226 percent. These increases in toll messages have required considerable enlargement of the size of the circuit groups between distant points and have contributed largely to the major construction problems in the design and layout of the plant.

The reasons for the recent rapid growth in the toll business are many. The growth has no doubt been influenced by the good level of general business in all parts of the country. There has also been an increasing public appreciation of the extent to which telephone toll service is of value in both business and social life and of the variety of uses to which it can be put. This is evidenced by the increasing number of by-

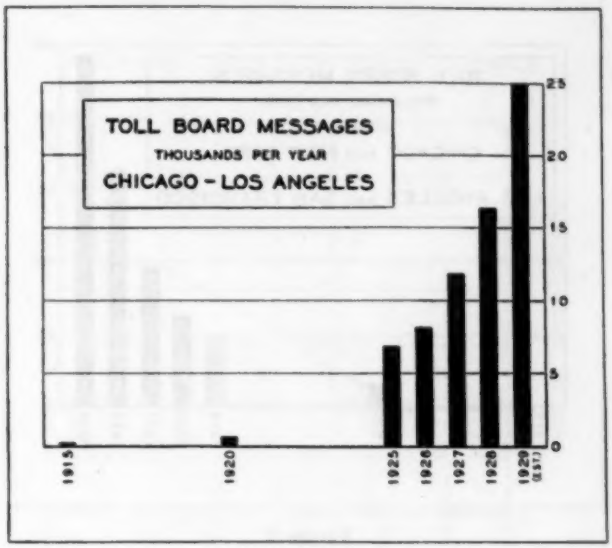


FIGURE 4

product uses and services which the toll user is constantly requiring. The continued development of economies in plant design, tending to limit increases in telephone rates to a much lower percentage than the general level of prices and which has made possible several recent rate reductions, is without doubt another important influence.

Considerable added stimulation to the growth of the toll business has undoubtedly resulted through improvements in the quality of the service given. Possibly the most important improvement in this respect is the increase in the speed of the

service, that is, the decrease in the time which elapses between the placing of a call and its completion. This is shown in Figure 6. The improvement is greater for the long distance calls than for the toll service as a whole, the average speed for the toll board traffic being about 2½ minutes in 1928 as compared with almost 7 minutes in 1925.

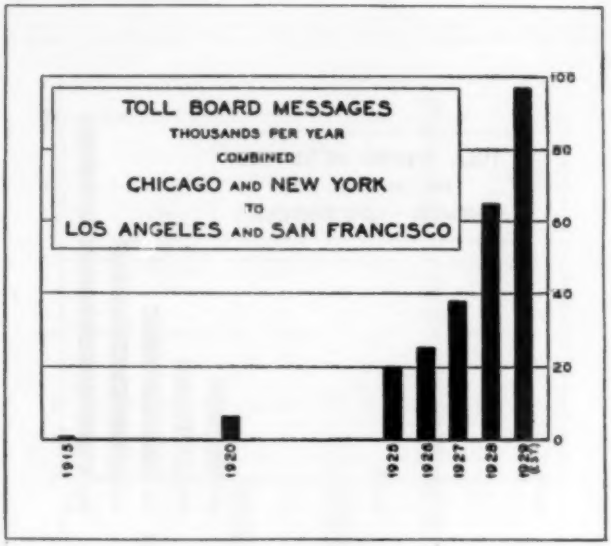


FIGURE 5

The increase in the speed of handling toll service has been largely brought about by the introduction of improved operating practises and facilities which have permitted the use of simplified methods of operation similar to those employed for local business. An increasing amount of the shorter haul toll business is handled directly by the local operator who first answers the subscriber's call. The speed of the large part of the longer haul business which must be handled by toll board operators has been greatly increased by arrangements whereby the toll operator first receiving the call is enabled to do both the recording work and the switching necessary to complete the call.

The result of the materially faster service has been that over 95 percent of the total toll messages are completed or reported upon while the subscriber remains at the telephone, without requiring him to hang up and be called again.

Another important improvement in the quality of service has been brought about both through large increases in the volume of sound delivered at the end of the toll circuits and

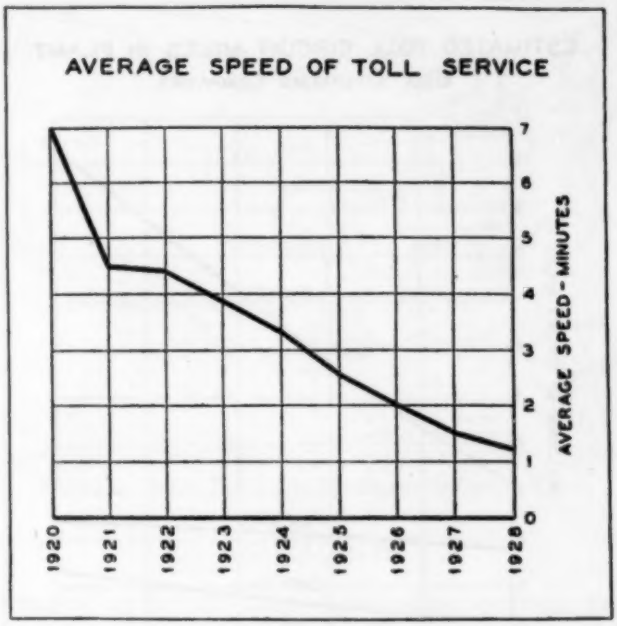


FIGURE 6

by improvements in the design of circuits, resulting in the greater distinctness and naturalness of the messages. This has included the use of methods providing for the efficient transmission of a much larger proportion of the component frequencies which make up speech. These improvements have largely reduced the percentage of messages in which the clearness of transmission is judged to be unsatisfactory, at the present time this being about 1 percent for the total toll traffic.

Other improvements in service have led to greater freedom from the possibility of interruption of the service and to its improvement in other respects. While much remains to be done in the further perfection of the toll service, it is believed that material progress has been made in fitting it to the needs of the customer and this has, no doubt, been one of the outstanding reasons for the rapid growth.

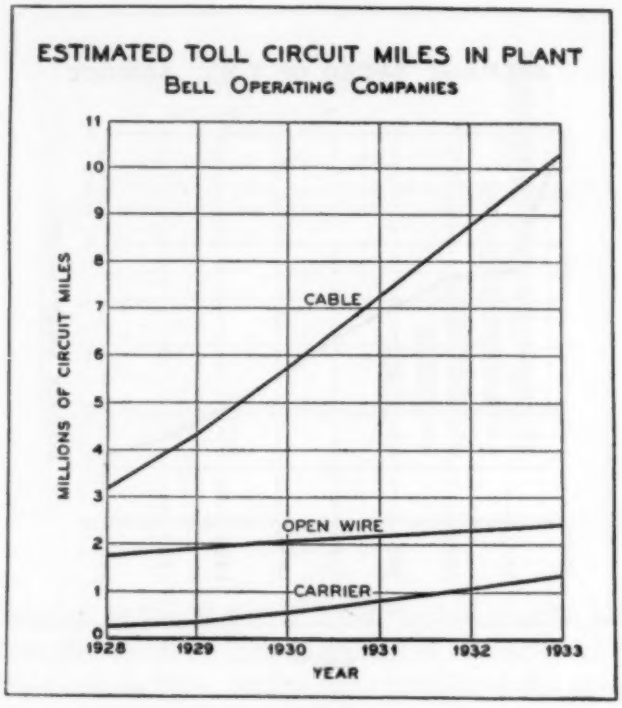


FIGURE 7

ADDITIONS TO PLANTS

The rapid growth in the toll business has required a great expansion of the toll plant and has been accompanied by material changes in the character of the plant and in the nature of the engineering problems. This expansion has been particularly marked in the case of the toll cable plant, additions to

which have been experienced in practically all parts of the country. An interesting illustration of this expansion is given in Figure 7, which shows the relative proportions of the three important types of toll plants at the end of 1928 and the estimated trend for this year and the immediate years following.

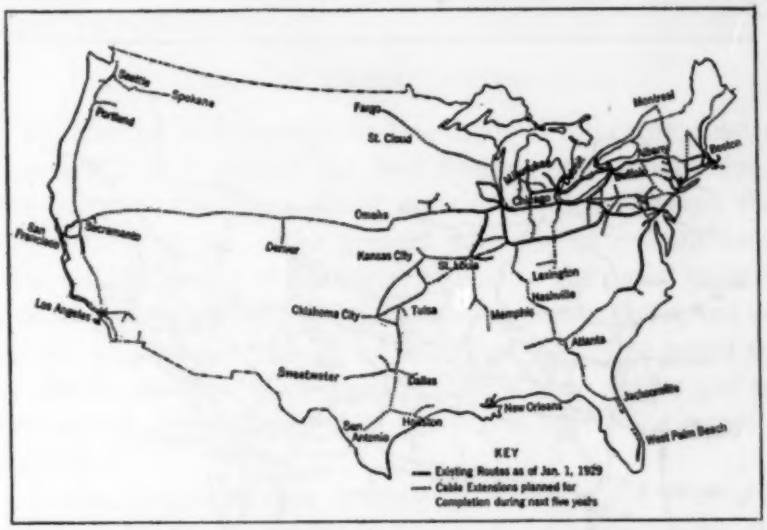


FIGURE 8. Main Toll Cable Routes of the United States

TOLL CABLES

It is interesting to note that of somewhat over six and a half million circuit miles in toll plant estimated for the end of this year, approximately four and a quarter million will be in toll cable. This percentage will be constantly increasing with the immediate following years. The extension of the toll cable program over the next five-year period contemplates cable on a large proportion of all of the major toll routes of the country. The magnitude of the proposed cable networks is shown in Figures 8 and 9. Figure 8 illustrates the main toll cable routes of the United States and Canada. Figure 9 shows the main cable routes and extensions in the northeastern area of the

United States and Canada, the development in this area being considerably more dense than in any other section of the country. It will be seen that in accordance with these proposed five-year plans toll cable will extend entirely across the continent and up and down the length of both the Atlantic and Pacific coasts, as well as practically from Canada to Mexico

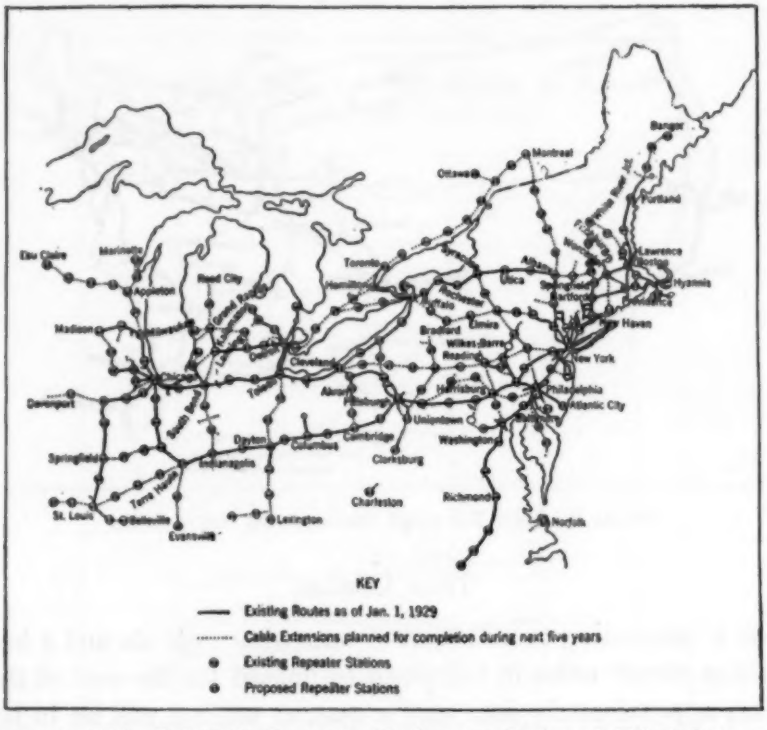


FIGURE 9. Main Toll Cable Routes in Northeastern Section of United States and Canada

in the central part of the country. With the completion of this large toll cable program, it is apparent that some of the toll messages will be routed within the five-year period through more than 4,000 miles of cable.

The toll cable which will be installed in the Bell System this year will amount to nearly 5,000 miles. This amount will be

increased to between 6,000 and 7,000 miles for next year, and it is expected that the yearly additions will continue at that rate or even higher for the next few years thereafter. The estimated construction expenditures for the toll cable additions during 1929, including the supporting structures, conduit runs, and repeater and terminal equipments, will be in the order of about $100,000,000.

Types of Cable Construction

Both aerial and underground methods of toll cable construction are widely used in the Bell System, the construction at the present time being about equally divided between these two general types. The greater part of the present longer haul toll cables are of the aerial type. In the aerial construction, the cable is suspended from a steel messenger strand supported on poles, as illustrated in Figure 10. The aerial type of construction is, in general, limited to two cables per pole line and is, of course, used in the places where the growth is moderate.

The underground type of construction up to the present has consisted for the most part of cables drawn into multiple duct, usually of vitrified tile, although in certain sections of the country some use has been made of creosoted wood duct. The underground construction has naturally been employed in cities and metropolitan areas and in heavy and rapidly growing cable routes as between the cities of the Atlantic seaboard and between Chicago and New York, where the provision of facilities for placing a number of cables within a reasonable period of time is important. One of the first toll conduit and cable installations was made in 1908 between Chicago and Milwaukee.

During the past year trial installations have been made of two new types of underground construction designed to meet conditions where one or two cables will handle the requirements for a considerable number of years. One of these con-

sists of a lead sheath cable pulled into a single fiber duct. In the other, a specially protected cable is buried directly in the ground without the use of ducts. The protection, known as tape armor, is applied over a lead covered cable of conventional design, the armoring consisting of coverings of impregnated paper, jute, and steel tapes which safeguard the lead sheath from soil corrosion and mechanical damage. In both of these types of construction, manholes are built only at loading points and thus about 90 percent of the manholes employed in the more usual conduit structure are omitted.

The splices at the junctions of the sections of tape armored cable between the loading points are encased in split cast iron cases filled with asphaltum compound to prevent contact with the earth. Splices at similar locations in fiber duct installations are covered by large fiber sleeves. The placing of the tape armored type of cable is illustrated in Figure 11. This type of buried construction appears to have advantages for some conditions where the rate of growth is not rapid. One interesting characteristic is reduced susceptiveness to inductive influences due to the shielding effect of the armor.

Both of these two types of construction have given satisfactory results in trial installations and it seems probable that they will find a considerable field of use in the Bell System.

Toll Cable Construction and Maintenance

The large annual additions to the toll cable plant necessitate the utmost care and precaution in planning and carrying out the construction and maintenance of this plant. The selection of the route for a toll cable is a matter of great importance, involving consideration not only of first cost and annual charges but freedom from inductive disturbances, permanency of routes, accessibility, and good co-ordination with existing telephone plant. The assurance of relative freedom from interruptions to service of the toll cable plant requires also very

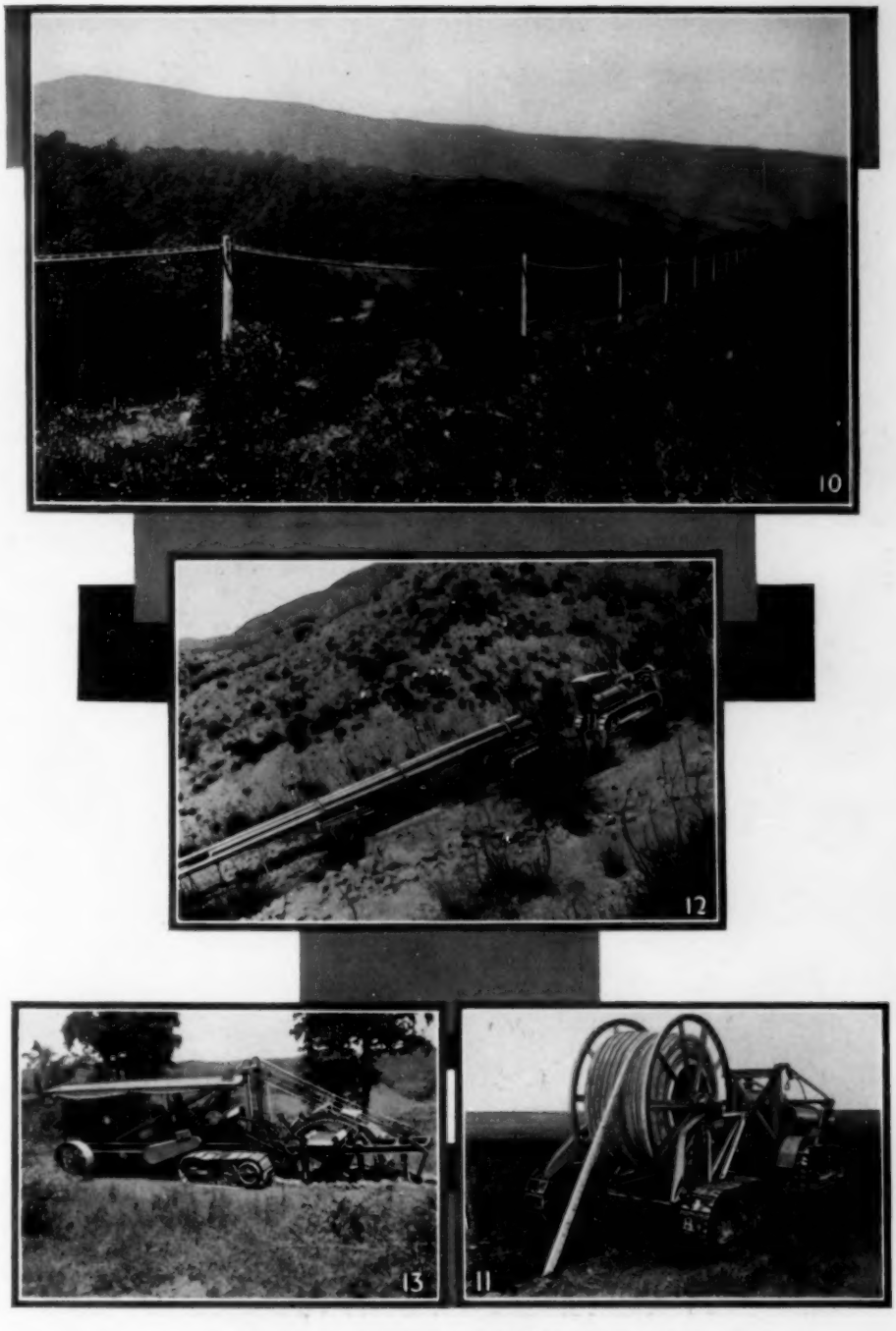


FIGURE 10. Aerial Type of Toll Cable Construction
FIGURE 11. Placing Tape Armored Type Toll Cable
FIGURE 12. Transporting Poles up Steep Grades on Tractors and Trailers over Private Right-of-Way
FIGURE 13. Heavy Duty Trenching Machine

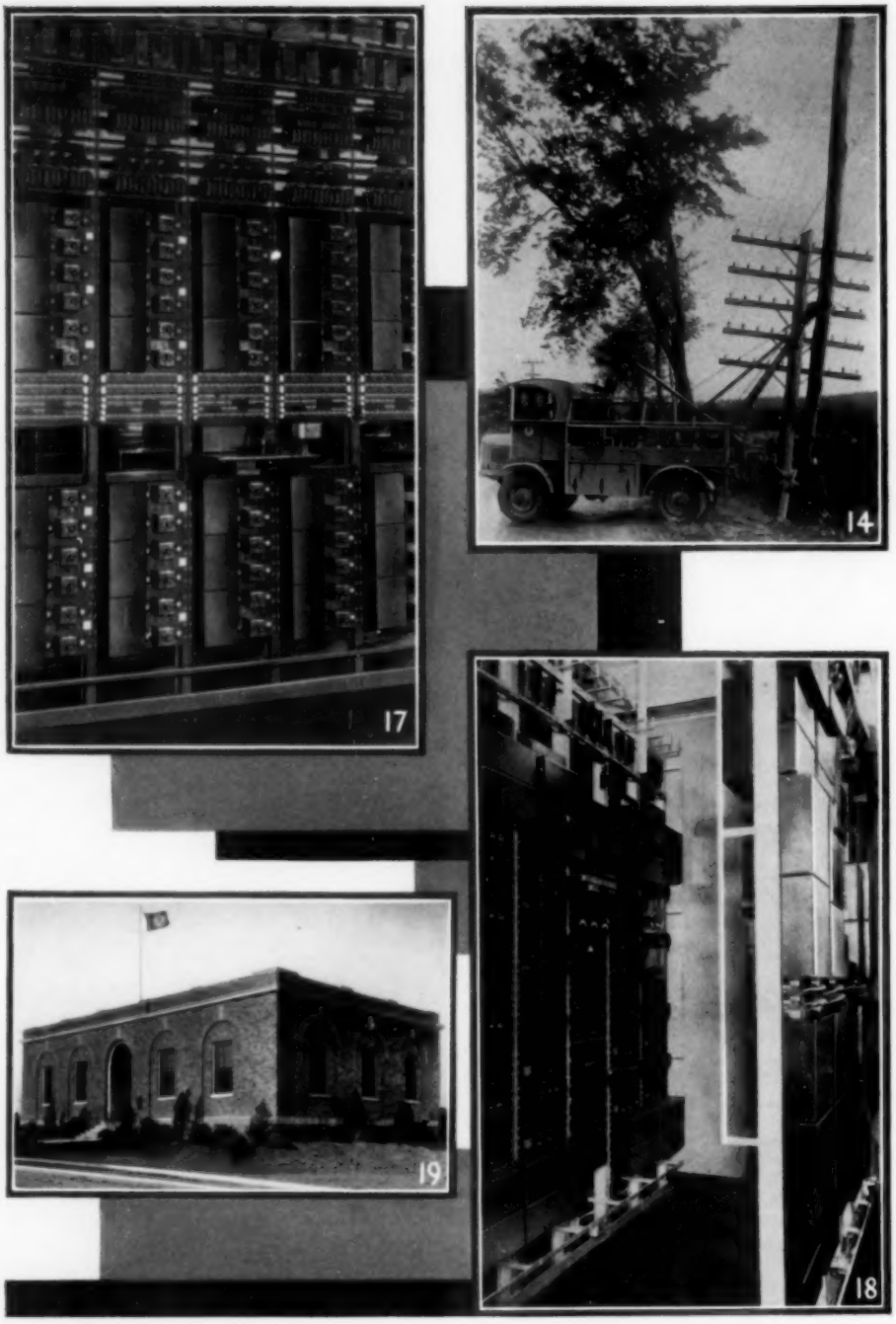


FIGURE 14. Earth Boring Machine and Derrick on Four-Wheel Drive Truck
FIGURE 17. Installation of Voice-Frequency Telephone Repeaters and Associated Apparatus
FIGURE 18. Assembly of Long Haul Carrier Telephone System Terminals
FIGURE 19. Typical Repeater Station Building

careful consideration of suitable maintenance practises. Preventive measures are continually being developed and applied to the cable plant to aid this work. Interesting in this connection is the application of continuous gas pressure and associated alarm gages for the detection of cable sheath failures.

Other measures have been taken to minimize maintenance troubles on the toll cables. For example, much study has been given to the matter of securing the proper tension in the aerial cable suspension strand and a proper relation between the strand and cable tensions in order to obviate buckling of the cable due to temperature changes. Also, in placing cables in the usual multiple tile conduit before the cables enter the manholes, they are brought into a parallel formation, one above the other, by spraying the ducts at these points. By the use of this construction, the cables can be placed in the manholes free of bends.

There is also the necessity for very fast installation work in connection with the large toll projects, involving the desirability of making the fullest possible use of automotive and labor-saving equipment especially adapted for handling the pole, wire, cable, and conduit construction. This special automotive and construction apparatus includes such units as: four-wheel drive trucks, some of which are equipped with earth-boring machines; six-wheel heavy delivery trucks, several kinds of power derricks, trenching machines, back fillers, tampers, tractors, and several varieties of trailers. On private rights-of-way, as for instance over plowed fields, the ordinary wheel type trucks and trailers cannot be satisfactory used so specially equipped caterpillar tractors and trailers with caterpillar tracks are employed. Some of the more important applications of labor-saving machinery in construction work are illustrated in Figures 12, 13, and 14.

Aerial Wire and Carrier

In spite of the magnitude of the toll cable program, it is expected that it will be necessary, in order to meet the demand for additional toll circuit facilities, to string this year about 180,000 conductor miles of open-wire facilities and to install about 200,000 channel miles of carrier telephone facilities. The majority of this wire stringing will, of course, take place on existing open-wire lines not closely paralleled by toll cables. The increased use of carrier telephone facilities has materially favored the further extension of the open-wire along the long toll routes. The open-wire and carrier circuits now being designed are high grade facilities and their service characteristics and economies are such that a considerable portion of the open-wire and carrier facilities will be retained after they are paralleled by new toll cables.

Major problems presented by the open-wire and carrier construction have been those of crosstalk in the carrier circuits and noise in the very long voice-frequency circuits. In general, the magnitude of the crosstalk problems may be more fully appreciated when it is considered that carrier operation at present involves frequencies about twenty times higher than those important in causing crosstalk in voice operation and wavelengths about one-twentieth as long. Furthermore, the influence of surrounding wires, in parallel with the earth, gives rise to "second order effects" which become very marked within the carrier frequency range. Consequently, the inductive coupling per unit length between circuits is increased about in proportion to the increase in frequency, a greater number of transpositions within each wavelength is required, the carrier facilities must be balanced with respect to second order effects as well as directly to each other, and the effects of irregularities in construction must be minimized to the greatest practicable extent. It has, therefore, been necessary to give careful consideration to transposition methods and

wire arrangements which would provide satisfactory crosstalk reductions and at the same time allow a maximum use of carrier facilities so that the large economies involved in superposing carrier telephone facilities on the open-wire plant may be obtained.

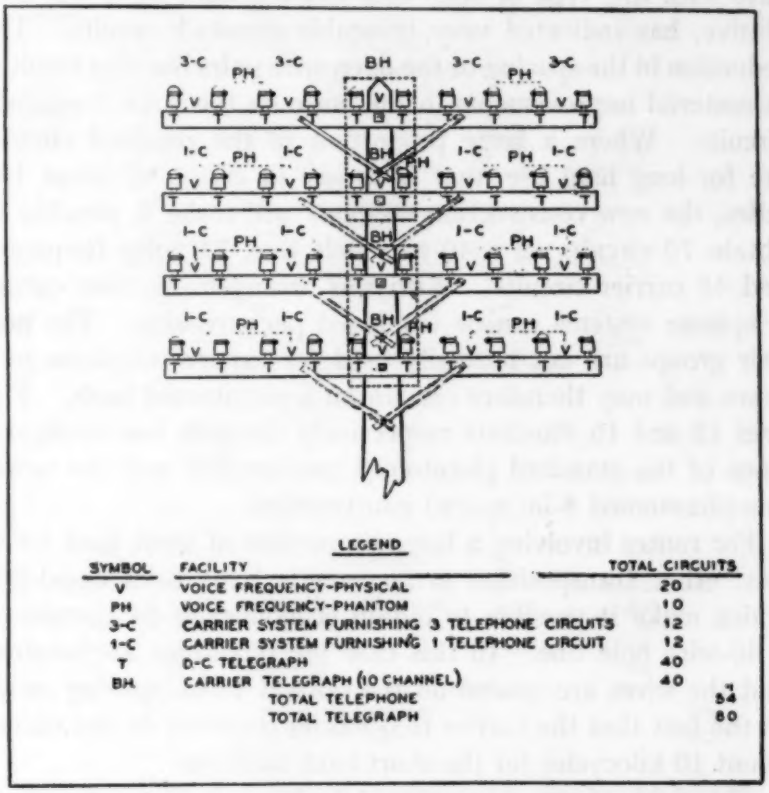


FIGURE 15. Pole Line Configuration. Phantomed Construction. 12-in. spacing between wires of non-pole pairs

This has resulted in trying out in the plant an entirely new form of open-wire construction. The new method involves abandoning the phantoms on the open-wire pairs on which the carrier facilities are to be superposed, reducing the spacing between the wires of these pairs to 8 in., and widening the

spacing between the wires of adjacent pairs to 16 in. The pairs to be used with carrier facilities are transposed in accordance with transposition systems which are especially designed to reduce adequately the coupling between the pairs at the higher carrier frequencies. The experience obtained to date with this type of open-wire construction, while not conclusive, has indicated very favorable crosstalk results. The reduction in the spacing of the open-wire pairs has also resulted in material improvements in the noise on the voice frequency circuits. Where a large proportion of the required circuits are for long haul use, that is to say in excess of about 100 miles, the new construction methods will make it possible to obtain 70 circuits on a 40-wire pole line, 22 voice frequency and 48 carrier circuits. With this arrangement, four carrier telephone systems can be employed per crossarm. The pole pair groups are not normally used for carrier telephone purposes and may therefore remain on a phantomed basis. Figures 15 and 16 illustrate respectively the pole line configurations of the standard phantomed construction and the newer non-phantomed 8-in. spaced construction.

For routes involving a large proportion of short haul facilities, other transposition arrangements have been developed which make it possible to obtain economically 54 circuits on a 40-wire pole line. In this case the phantoms are retained and the wires are spaced on the normal 12-in. spacing owing to the fact that the carrier frequencies involved do not exceed about 10 kilocycles for the short haul facilities.

The field of use of carrier telephone facilities has been greatly increased with economies and improvements in two types of carrier telephone systems developed within the past few years. One type of system employs a frequency range of 5 to 30 kilocycles and provides three additional telephone channels normally used for long haul circuits from about 125 miles upward. Suitable intermediate repeaters are available for use with this system so as to greatly extend the range of

its practical application. The longest systems of this type now in service are between Davenport, Iowa and Sacramento, California, a distance of almost 2,150 miles.

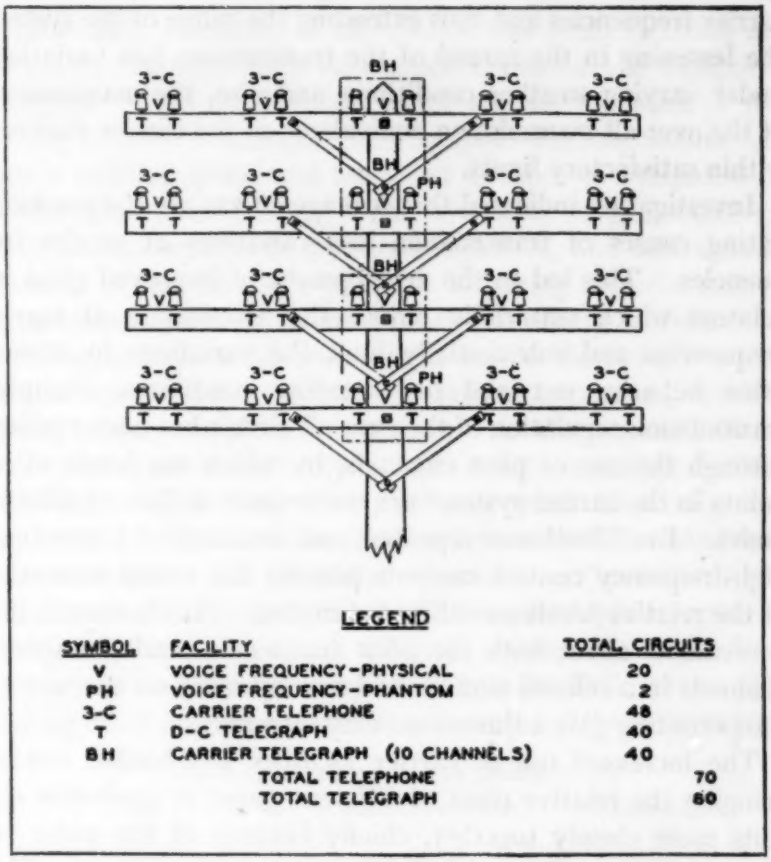


FIGURE 16. Pole Line Configuration. Non-Phantomed Construction. 8-in. spacing between wires of non-pole pairs

The other system, employing a frequency range from about 4 to 10 kilocycles, provides a single additional telephone channel normally employed to provide short haul facilities, ranging from about 75 to 125 miles. No intermediate repeaters are used with this system. Under special conditions this sys-

tem can be extended to operate over approximately 200 miles, by the addition of extra terminal amplifier equipment.

Other considerations in the use of long haul carrier telephone systems have been those of reducing the transmission losses at carrier frequencies and thus extending the range of the system, the lessening in the spread of the transmission loss variations under varying weather conditions, and also, the maintenance of the over-all transmission equivalents of the carrier channels within satisfactory limits.

Investigation indicated that leakage effects are the predominating causes of transmission loss variations at carrier frequencies. This led to the development of improved glass insulators which materially reduce the attenuation at carrier frequencies and substantially limit the variations in attenuation between wet and dry weather conditions. Suitable transmission regulation of the over-all circuit has been realized through the use of pilot channels, by which the levels at all points in the carrier systems are maintained within established limits. Rectification at repeaters and terminals of transmitted high-frequency control currents permits the visual indication of the relative levels on calibrated meters. As changes in line equivalents affect both the pilot frequencies and the speech channels in a related manner and are indicated on the meters, compensating gain adjustments may be made.

The increased use of carrier facilities has tended toward bringing the relative costs of different gages of open-wire circuits more closely together, chiefly because of the wider repeater spans possible with the larger gage conductors. This is especially true of the 128-mil diameter open wire circuits which are, in general, not materially different in cost from the 104-mil circuits when completely equipped for voice-frequency telephone, d-c. telegraph, and carrier telephone facilities. This has helped make economical the increased use of the larger 128-mil and 165-mil facilities throughout the open-wire

plant, which is very advantageous in lessening the service interruptions due to wire breaks.

Toll Equipment Program

The rapid extension of the outside toll plant facilities has, of course, resulted in a very much increased toll equipment program. This has involved much engineering work in providing suitable switchboard and equipment arrangements, adequate building space, and improved methods of equipment assembly and office cabling. The extremely long distance circuits require numerous telephone repeaters, and the rapid expansion of the toll cable program, requiring repeater stations approximately every 50 miles, has materially increased the building and space requirements as well as the needs for additional repeaters, ringing and compositing apparatus, and adequate battery supply arrangements. As the present full size toll cables provide as many as 325 circuits, it is apparent that with many paralleling cables, building space frequently must be made available at one locality for several thousand telephone repeaters and associated apparatus. The following table, illustrating the increase in the use of telephone repeaters and carrier systems, shows the total number of telephone repeaters and carrier systems installed in the Bell System plant during 1925 and the estimated additions for the year 1930.

Estimated Additions to Bell System Plant

Year	Telephone repeaters	Carrier systems
1925	2,400	11
1930	36,000	400
Ratio	15	36

Simplified equipment arrangements have been developed which involve mounting apparatus on panels assembled on channel iron or I beam racks, thus bringing about substantial reductions in the space required as compared to the former types of mountings. The panel mounted arrangements have also considerably simplified the cabling arrangements between

the various units of the toll circuit equipment required within a given office. Also, in order to simplify the layout and installation of the toll circuit equipment, arrangements have been developed whereby certain equipment is now shipped direct from the factory on completely assembled bays. Figure 17 shows a bay of voice frequency telephone repeaters arranged in accordance with the latest methods of assembly and cabling. The simplification of the equipment arrangements is further shown in Figure 18, which illustrates the complete assembly of two long haul carrier terminals with their associated testing apparatus, on standard bay arrangements.

The improved equipment arrangements have materially aided the repeater station building problem and floor plan layouts. The repeater station buildings which are being constructed throughout the country to house toll circuit equipment are, in general, fireproof buildings so designed that they may be extended vertically or laterally, depending upon the particular land conditions or other requirements involved. Figure 19 shows a typical telephone repeater station on one of the major cable routes. This building now contains about 1,000 repeaters. Telephone repeater station buildings are being constructed in several parts of the country which are designed to have an ultimate capacity of 10,000 repeaters.

Electrical Design Features

The development of very long toll telephone circuits has involved working out a succession of very interesting design features in order to obtain suitable electrical characteristics for the clear transmission of speech over these long circuits. These problems have, in general, been particularly great for very long toll cable circuits. They have been discussed in detail in a number of papers presented before the Institute. A brief review of the general nature of some of these problems

and the method of solution adopted for toll cable circuits will be sufficient here.

In the early extensions of toll cables, difficulty was experienced because of the much higher losses of energy for the high-frequency components of speech than for the low-frequency components due to the large variation in attenuation of the cable for currents of different frequencies. This difficulty was met by the use of "loading," by means of which the attenuation was made much more nearly constant over the band of frequencies most important for the transmission of speech. The loading also greatly increased the efficiency of cable transmission by increasing the impedance of the circuit so that for a given power higher voltages and lower currents are used on a loaded circuit than on a circuit without loading. This made possible such cables as the early Chicago-Milwaukee cable, previously mentioned, and, by using as large gages of conductors as seemed practicable, provided satisfactory service through cables between New York and Washington and New York and Boston, distances of about 250 miles. These cables were completed in 1914.

Further extension of the range of cable transmission was limited by the difficulty of obtaining satisfactory over-all efficiency in cable on circuits of 200 or 300 miles in length. This difficulty was largely solved by the perfection of telephone repeaters, particularly those using vacuum tubes. In the design of long telephone circuits, even those in cable, it is now practicable to renew the energy of the telephone currents repeatedly without material distortion to a practically unlimited extent.

With the resulting extension of toll cable circuits to relatively great distances, as between Chicago and New York, another phenomenon became of importance. At the ends of a telephone circuit the telephone currents are in part delivered to the terminal apparatus and in part reflected back over the line due to the difference in the impedance of the line and the

terminal apparatus. This effect also takes place in a minor degree at intermediate points in the line where discontinuities in electrical characteristics occur. When the time of transmission is very short, these reflected currents do not cause interference with speech unless they are relatively great in magnitude. When the time of transmission is appreciable, however, the reflected currents are heard in the telephone receivers both by the talker and by the listener as echoes. These echoes may have a serious effect in impairing the clearness of speech, the effect being progressively greater as the time lag of the echo current increases.

A first remedy for these effects was an increase in the velocity with which telephone currents were transmitted over the loaded cable circuits. This was done by a change in the design of the loading which also had other important benefits. With further increases in distance and in the efficiency of circuits, however, additional means were required to take care of these echo effects. This has been done by the development and use of means for suppressing the echoes by destroying the efficiency of the return path, that is, the transmission of speech currents in one direction over the circuit acts to prevent the transmission of echo currents in the opposite direction.

One important problem in the longer circuits has been the prevention of changes in efficiency with variations in the temperature of the circuit. The importance of this is illustrated by the fact that the energy loss in a Chicago-New York toll cable circuit may be as much as 10^9 times as great when the circuit is hot as when it is cold. The daily and even the hourly variations are sufficient to cause large variations in efficiency if not compensated. This compensation is done by the automatic change in the gain of amplifiers which is controlled by the resistance of pilot wires running through the cables and subjected to the same variations in temperature as the circuits used for message purposes.

In the longer cable circuits, the best system of loading which

it has seemed practicable to employ, does not sufficiently eliminate variations in efficiency with frequency to permit the transmission of speech currents without serious distortion unless further means are provided. In such circuits, therefore, use is made of so-called "attenuation equalizers," inserted periodically along the circuit, to compensate for the variations in efficiency of the line and associated apparatus.

Another phenomenon which becomes of importance with increased length of circuit is the variation in the velocity of propagation over the circuit of different components of speech. The components of moderate frequency (about 1,000 cycles) tend to arrive at the distant end first, those of higher and lower frequencies trailing in later. This produces an additional type of distortion. Some of this distortion can be minimized by improvements in the design of the apparatus. The use of corrective networks which insert in the circuit a distortion in velocity of transmission which compensates that caused by the cable circuit characteristics is also being studied to take care of this situation.

With all of these progressive difficulties removed, it appears, looking to the future, that the limit of transmission over telephone cable circuits may be influenced by the operation of another and still more fundamental factor, namely the time required for the transmission of electric currents over these very long circuits. With the development of toll cable networks covering this country and Europe and with the completion of telephone cables across the Atlantic, total distances of transmission over toll cable circuits as great as 10,000 miles will probably be involved in the future. The types of cable circuit now used for very long distances have a velocity of propagation of about 20,000 miles a second. The time lag in a 10,000-mile cable circuit would be about half a second for transmission in each direction. A delay of this magnitude would interfere with the ordinary methods of conversation involving frequent acknowledgment, interruption, and inter-

change of question and answer. Looking forward to improving such conditions, research work is now under way to determine the best means of providing cable circuits of still higher velocities.

International Connections

The toll system of the United States now has connection with telephones in 21 other countries. By this means the users of this service are offered connection with 65 percent of all of the telephones in other countries of the world or 85 percent of all the telephones in the world including those in this country. Additional extensions are made from time to time. These extensions to other countries involve many unusual plant arrangements and a brief mention of these is desirable.

Due to our very close relations with Canada, the Bell System connects with Canadian telephone systems at a large number of points. All of the larger cities and a large percentage of the smaller places are available for connection. In general, however, these connections involve no unusual problems, the ordinary types of construction standard in this country being extended in Canada where closely similar standards of construction are in use. Similarly, a connection make in 1927 to Mexico City and other important cities in Mexico by the extension of open wire toll lines involves no new technical features.

The connection of this country with Cuba was accomplished in 1921 by three submarine cables, of very unusual construction. These cables, 115 miles in length, cross the Florida Straits which have a maximum depth of about 6,000 feet. Because of the great depth, the type of construction used for transoceanic telegraph cables was necessary for mechanical reasons and this made necessary a novel electrical design of the cables to provide adequate transmission efficiency. The cables have proved very satisfactory and the availability of

these circuits has resulted in the gradual development of a large telephone business between points in the United States and Cuba.

In 1927 the first commercial service was opened between the United States and Europe by a circuit from New York to London. This has since been supplemented by two additional circuits and other additional circuits now under construction and planned will raise this group to six by the end of 1932. The first circuit includes for the transatlantic link a long wave radio system transmitting from points near New York and London to receiving stations in the eastern central part of Scotland and northern part of Maine, respectively. The other two circuits are short wave radio circuits, both transmitting and receiving stations being near the New York and London terminals.

These circuits, both the long wave and short wave, are of pioneer character. The effort has been to obtain as good a degree of continuity of service as transmission conditions will permit and consistent with requirements for satisfactory commercial services. In working to obtain this result one is, of course, faced with the very large variations in efficiency of transmission under various conditions and also in the magnitude of the interfering atmospherics which tend to interfere with good reception.

With the long wave transmission (5,000 meters), practically no degree of directivity of the transmitting antenna has been employed, although at the receiving antenna an improvement in the ratio of signal power to static power of about 400 to 1 is obtained by construction giving directive effects. In this connection, it might be noted that the northern location of both receiving stations is also an important factor in reducing noise. Relatively high powers are necessarily transmitted, the transmitting set power for long waves being about 200 kw. The power received by the receiving antenna is a small fraction if a micro-watt, sometimes being as small as 10^{-12} watt. It is

interesting to note that this power is equivalent to that received from the North star on 10 sq. in. of the earth's surface.

With the short wave transmission using wavelengths between about 15 and 45 meters, it is possible to obtain a high degree of directivity of both transmitting and receiving antennas. The gains from the antennas used during the most important hours as compared with undirected transmission and reception represent equivalent power advantages of about 70 to 1 and 30 to 1, respectively. The transmitting powers used are somewhat lower than with the long wave, being about 15 kw. The short wave channels are, in general, less affected than the long wave by high atmospheric disturbances, but are much more affected at times of magnetic storms when large variations in the field strength of the signal at the receiving antenna often occur. Fortunately these two types of disturbances seldom appear at the same time and the two types of radio channel admirably supplement each other in the maintenance of uninterrupted service.

Work is now proceeding in the design of a transatlantic telephone cable which will provide a third type of circuit between New York and London. For this cable, transmission will probably be overland from New York to Nova Scotia, thence by submarine cable to Newfoundland, then by a second cable 1,800 miles in length from Newfoundland to the Irish Coast, and from there to London. This cable presents so great a departure from previous telephone circuits that extensive research and development are necessary to determine the most favorable methods of construction.

An additional international connection which is now being constructed is of interest, namely, a short wave radio telephone channel between New York and Buenos Aires, connecting with Montevideo.

Planning for the Future

In one or two places in this paper mention has been made of planning for the future by the intensive study of technical problems which might, if unsolved, limit future extension of the service. The scope of this paper does not permit even an outline of the numerous research projects which it is necessary to carry forward with a view to assuring continuity of uninterrupted progress in extension and improvement of toll service. This is, however, a factor of fundamental importance both in the steps which have already been taken and those which are anticipated in future years.

From the general engineering standpoint, the plans for the continued expenditure over a period of years of large amounts for permanent extension of toll plant, call for very careful attention to the fundamental planning and layout of that plant. This is particularly true in view of the large extension of toll cables and of underground toll cable conduit routes in which best engineering requires that initial construction be designed with a view to the future increase in circuit requirements for a relatively large number of years. This then is one of the important features of the engineering work of the Bell operating companies at the present time.

While fundamental plans for future development of toll plant must adequately provide for the plant extension in a given area, they must be closely co-ordinated with each other and with the plans for the country as a whole, particularly because of the importance of the large groups of long through toll circuits. As one element in facilitating this planning, there has recently been developed for the country a general basic routing plan designed to insure the highest practicable standards of service as to speed, accuracy, and transmission with maximum economical concentration of circuits on important routes. This plan will serve to limit the amount of

switching required for handling toll calls between remote points.

In conclusion, I might add that those of us who are closely interested in the advancement and improvement of the toll phase of the telephone business look forward to a continued rapid development of that part of the communication art with an increasingly complex and varied engineering technique.

W. H. HARRISON

Romance of the Machine

A BOOK REVIEW

MICHAEL PUPIN has again taken up the pen. Professor Pupin is best known to telephone people as the inventor of the loading coil, and to thousands of other readers as the author of one of the most interesting and inspiring of modern autobiographies, "From Immigrant to Inventor." This clear-thinking man of science has now produced a small, pocket-sized volume to which he has given the alluring title of "Romance of the Machine." Its one hundred or so of pages are packed with interest for all Americans, and particularly for those who are engaged in any branch of the development of the communication art.

The book is a vigorous defense of what certain European critics have called our American "machine civilization." To these commentators, the aim and object of American scientific endeavor has been far too generally the application of research to production—to the making of machines. They see in America a civilization already become wholly mechanistic and materialistic—a widespread deification of the machine that is nothing less than heathen idol worship.

With such a view Michael Pupin, who is almost a zealot in his Americanism, has small patience. It is not the scientist alone who speaks in these pages. It is the Serbian boy, now grown to maturity. It is the immigrant, arriving in New York at the age of seventeen, penniless and unable to speak a word of English. It is the youth toiling in factory and foundry, in laundry and in store, grimly refusing to believe that America held no opportunity for such as he. It is the night student at Columbia, the professor of electro-dynamics, the winner of the Edison Medal and of the Pulitzer Prize, the

recipient of some of the highest scientific honors in the gift of America.

Such is the background against which the reader must view "Romance of the Machine," for background and book are often so merged that one becomes part of the other. As the writer reveals himself in its pages, there is in him something of the scientist—the seeker of knowledge for its own sake; something of the inventor—who talks authoritatively of machines because he has helped to make them; something of the poet and the mystic—who sees all creation as a vast machine functioning in its most minute details in accordance with the plans which brought it into being. There is in Michael Pupin, as one sees him through the words he has written, something of all this—plus a fervent patriotism that has prompted him to study America more closely and more understandingly than have most of her American-born citizens.

To the poet in Michael Pupin, as well as to the scientist in him, the universe appears as a huge "cosmic engine." To him, trains of clouds driven through the sky carrying their "life sustaining fluid to the thirsty hillsides and valleys" are so many machines propelled by the force of solar radiation. In tree and herb, in leaf and trunk and stem, drinking up life from the earth and absorbing power from the stream of solar energy, he sees the primordial machine of which "the physical activity of our 'Machine Civilization' is a tiny and crude copy, only."

If man worships the machines he himself has made, he intimates, it is because their heavenly origin has made them worthy of worship. In making machines, man has merely listened to the voice of nature. "The machine," Professor Pupin declares, "is the visible evidence of the close union between man and the spirit of the eternal truth which guides the subtle hand of nature." Almost exultantly, and certainly without apology, he concedes that, in this sense, science worships the machine. But he adds, "it is not the material ma-

chine or its material service, but the spirit behind them, which scientists and engineers worship."

Professor Pupin shows that, in the field of abstract research, America has made notable contributions to the growth of scientific knowledge, citing such outstanding examples as Joseph Henry, William Draper and Josiah Willard Gibbs. He contends that if scientific effort in the United States has been directed particularly toward applied science—toward the making of machines—it has been because the rapid growth of the country has demanded this.

The Consolidation of the Union

Treating this phase of his subject, Professor Pupin delves deep into American history and shows that the period from the close of the American Revolution to the end of the Civil War was a period during which the machine was sorely needed in the making of the American nation. He summons Washington and Lincoln, outstanding idealists of this period and of all American history, and calls upon them to testify to the value of the machine—and especially of those machines or instrumentalities which are involved in the service of providing communication—as factors in national development.

A striking phrase from the writings of Washington is from a report which accompanied the presentation of the federal constitution after its adoption by the constitutional convention. In this document Washington declares that the fundamental purpose of those who drafted the constitution was "the consolidation of the Union." This phrase Professor Pupin makes, as it were, the text of a considerable portion of his book. He shows that the "consolidation of the Union" was the purpose that lay behind Washington's lifelong interest in such instrumentalities of communication as canals, inland waterways and improved highways. He declares that one of the first of Lincoln's announced political policies called for the development

of railways and canals as factors which would make for the "consolidation of the Union."

At the close of this period that lay between America's two great wars, the need of communication facilities became doubly urgent, Professor Pupin points out.

"At the end of the Civil War," says he, "the physical structure of the United States was still like a huge and perfectly formed embryo in which a nervous system had not yet reached its last stage of growth." To meet the needs of this situation, new instrumentalities of communication were created. One of the most important of these was the telephone.

Describing the first public exhibition of the telephone at the Philadelphia Centennial Exposition in 1876, Professor Pupin significantly comments: "No visitor to this exposition suspected that this tiny electrical machine, the telephone, would be some day a most powerful instrument in the consolidation of the American Union."

Of the effect of the machine in general, and of modern facilities for communication in particular, upon our national life, the author has this to say:

> "Consolidation of the Union, the dream of Washington and of Lincoln, is today a reality, much more complete and beautiful than seemed possible at the time Lincoln delivered his Gettysburg address. History does not record so great an achievement in so short a time in the life of any other nation. But no other nation had the aid of the consolidating power of the machine at the time when it sorely needed it. . . . It was providential that no other period in human history was more productive of new machines than this period. That we contributed more to this productiveness than any other nation shows only that the aid of machines meant much more to our growth than it did to the growth of any other civilized country."

"Romance of the Machine" devotes considerable space to the discussion of various forms of communication and transportation facilities which have had and are having a part in promoting the "consolidation of the Union." Professor Pupin

discusses not only the telephone but the vacuum tube oscillator, the invention of which has made possible the development of radio telephony, and particularly of radio broadcasting. He also pays tribute to the automobile and to the airplane, both made possible by the development of the gas engine, as factors in drawing the widely scattered sections of the country into closer relationships.

Of the telephone and the vacuum tube he writes:

"It looks like an act of providence that the telephone was born when the consolidation of our Union needed it most; the vacuum tube oscillator arrived in time to lend its aid in the consolidation of this nation with the other nations of the world. Many an enthusiast believes that these two machines are messengers sent from heaven to aid in the guidance of this nation, and of the whole world."

An Economic Democracy

Perhaps the most interesting portion of the book, to telephone people at any rate, is that which deals with the telephone, not as an instrumentality of communication, but as an industrial development. The author points out that the American ideal of political democracy, as described in Lincoln's Gettysburg address, "was destined to give birth to a peculiarly American ideal of economic democracy which is, broadly speaking, a corollary of Lincoln's ideal of political democracy." This ideal, he continues, "demands that the wealth-producing activities of our nation should be for the benefit of all the people, and not for the benefit of single groups of people."

Tracing the history of the development of the telephone as an industry from its earliest days to the present, Professor Pupin writes:

"Our telephone industry was undoubtedly the first large American industry which blazed the way in the direction of industrial democracy. This was perfectly natural; it started as a large number of tiny local telephone corporations, most of them independent of each other, and each of them looking ahead to its own individual advancement. Such a state

of things paralyzed progress in the telephone art. Mergers and consolidations were sorely needed, and dire necessity forced these tiny and numerous local corporations to merge in spite of the legislators, who dreaded the approach of a big telephone monopoly. An industrial organization extending to every part of our vast territory was the result of this merging process, resembling in a striking manner the result of the consolidation of the United States. It is obvious that in a great telephone industry, rising gradually out of the merging of numerous small corporations, the stockholders as well as the subsidiary companies were spread over the whole of the United States. A co-operation between them was badly needed. American genius for co-operative organization proved equal to the task; the final result was an industrial democracy."

The author might well have added that, just as the American political democracy had its origin in the vision of certain far-sighted men, and has grown along the lines which they planned and predicted, so this industrial democracy has grown along predetermined lines. A nation-wide telephone service and the nation-wide industrial organization to provide it are not the product of mere mergers, brought about by force of necessity. The American telephone industry of today did not simply evolve.

The telephone was less than a decade old when Theodore N. Vail wrote confidently of such a service:

"Tell our agents that we have a proposition on foot to connect the different cities for the purpose of personal communication, and in other ways to organize a grand telephonic system."

It is worthy of note that within ten years of the first public exhibition of the telephone, the working organization of the business had taken substantially the form which it has today. The original scattered licensees had combined their territories and their organizations and permanent licenses had taken the place of the earlier temporary arrangements, and there was thus created a group of telephone companies operated under patents owned and controlled by the parent company in territories clearly defined and taken together covering the entire country.

This process of growth, begun in the foresight of the founders of the telephone business, has brought into being the American telephone service of today, which, as Professor Pupin points out, is provided by an organization of four hundred and fifty thousand American men and women, operating physical properties representing an investment of four billions of dollars which are owned by more than five hundred thousand stockholders.

"Here is an industry," he declares, "which is practically owned by the people of moderate means; many of them are in the employ of the industry. . . . This industry was destined to advance along paths which lead to industrial democracy, and it has arrived there."

"Who can contemplate the great achievement of the industrial democracy inaugurated by the telephone industry," he asks in another portion of the book, "without being assured that it is a joyful message of an approaching civilization which will be more just and generous to the worker than any that the world has ever seen?"

"No other American industry is so typically American as our telephone industry. . . . We are proud of our telephone industry and of our machine civilization which this industry represents so well. Our European critics will never understand our civilization until they have mastered the present structure as well as the past history of our telephone industry."

R. T. Barrett

Notes on Recent Occurrences

OVERSEAS TELEPHONE NOW REACHES ROME, WARSAW AND HELSINGFORS

PRACTICALLY the whole of northern Italy and the city of Rome were brought within reach of North America by telephone on January 15, with the extension of transatlantic telephone service to the seven "regions" south of the Alps. On February 1, Warsaw, the capital of Poland, was also brought within the scope of the service, which was again extended on March 8 to include the city of Helsingfors, the capital of Finland.

The addition in Italy to the intercontinental network covers the Cisalpine Gaul of ancient times and Liguria. It includes Milan, Turin and Genoa, which have been connected to the transatlantic circuit for some months, and Venice, Trieste, Padua, Bologna, and many other cities famous in both ancient and modern times. The entire territory has approximately 195,000 telephones, serving a population of more than 20,000,000. Rome, with a population of 770,000, has 33,000 telephones.

Warsaw has about 50,000 telephones serving a population estimated at 1,100,000.

The extension to Helsingfors, crossing the sixtieth parallel of North latitude and reaching a new mark in eastern Europe, makes it possible to bridge, by means of an intricate linking of radio, submarine cables and land wires, a distance of more than 9,000 miles. The vast telephone system of which these are a part now stretches over forty degrees of latitude, or from semi-arctic to equatorial climates, and over 150 degrees of longitude,—nearly a half day's journey for the sun. When it is noon in San Francisco, at one end of the network, it is 9.15 at night in Helsingfors, at the other extremity.

Helsingfors has a population estimated at 230,000 with approximately 30,000 telephones or roughly thirteen instruments for every 100 inhabitants. The circuit from London, the European terminal of the transatlantic radio channels, runs through Stockholm, whence a submarine cable crosses the Baltic Sea by way of the Aland Islands to Abo in Finland. From there a land wire line carries it to Helsingfors.

The service will be available throughout the twenty-four hours, as in the case of the other European countries. The cost of a call from New York to any point in the added Italian territory, including Rome, is $51 for the first three minutes and $17 for each additional minute. The rates to Warsaw are $52.50 for the first three minutes and $17.50 per minute thereafter. To Helsingfors the rates are $53.25 for the first three minutes and $17.75 for each additional minute.

The added territory is now accessible to all telephones in the United States, Canada, Mexico and Cuba that are at present connected to the overseas radio-telephone circuits.

THE ANNUAL MEETING

AT the annual meeting of the stockholders of the American Telephone and Telegraph Company, which was held at the headquarters building, 195 Broadway, New York, on March 25, the annual report was approved and the Directors were re-elected. There were 9,003,991 shares voted.

SERVICE OPENED TO SOUTH AMERICA

TELEPHONE service between North America and South America was made available to the public on April 3d.

At eleven o'clock on the morning of that day President Walter S. Gifford of the American Telephone and Telegraph Company, in the Cabinet room of the Executive Offices, State, War and Navy Building, Washington, D. C., exchanged greet-

ings with Col. W. F. Repp of the International Telephone and Telegraph Corporation, in Buenos Aires, Argentina. This brief conversation served as a prelude to the official opening of the service by President Hoover who, speaking from Washington, conversed successively with General Carlos Ibañez, President of Chile, at Santiago; and with Dr. Juan Campisteguy, President of Uruguay, at Montevideo. Joseph P. Cotton, Acting Secretary of State, talked from Washington with the Chilean Minister of the Interior, the Uruguayan Minister of Foreign Affairs and the American Chargé d'Affaires at Buenos Aires.

The conversations between government and telephone officials in North and South America were heard by a distinguished assembly at Washington, including diplomatic representatives of the Republics involved and officials of the American Telephone and Telegraph Company and of the International Telephone and Telegraph Corporation. The ceremonies were broadcast over a coast-to-coast radio network and were also sent out by short wave transmission for the benefit of radio listeners in foreign countries.

This new service interconnects twenty million telephones in the United States, as well as all telephones in Cuba, and all the principal points in Mexico and Canada, with the telephones in the Argentine Republic and with the cities of Santiago in Chile and Montevideo in Uruguay.

The link between the two continents is a short wave radio telephone circuit 5300 miles in length connecting the overseas radio stations of the American Telephone and Telegraph Company in the United States with the International Telephone and Telegraph Corporation's stations in the vicinity of Buenos Aires.